RE: AN ORDINANCE FOR THE PURPOSE OF REPEALING AND READOPTING WITH REVISIONS THE CALVERT COUNTY TRANSPORTATION PLAN

WHEREAS, Calvert County has a Comprehensive Plan, Transportation Plan and Town Center Master Plans (hereinafter, the "Plans") that, together, guide the future growth and development in the community;

WHEREAS, the County Commissioners of Calvert County, with the advice and input of the public and the Calvert County Planning Commission, have adopted the Calvert County Comprehensive Plan, Transportation Plan, the Dunkirk Master Plan, the Huntingtown Master Plan, the Lusby Town Center Master Plan, the Owings Town Center Master Plan, the Prince Frederick Master Plan, the Solomons Town Center Master Plan and the St. Leonard Town Center Master Plan that, together, implement the visions of the Plans to regulate and control the zoning and use of land and buildings in the County to promote the public safety, health, and general welfare of the citizens;

WHEREAS, pursuant to MD. CODE ANN., LAND USE § 3-301, the Calvert County Planning Commission is required to review the aforesaid Calvert County Transportation Plan "and, if necessary, revise or amend" said Transportation Plan;

WHEREAS, as a result of the aforesaid review, the Calvert County Planning Commission determined that revision and amendment to the existing Calvert County Transportation Plan was necessary and, accordingly, prepared and developed the *Calvert County Transportation Plan, January 2020 Draft*;

WHEREAS, on December 18, 2019, following publication of due notice, the Calvert County Planning Commission conducted a public hearing to consider the aforesaid *Calvert County Transportation Plan, September 2019 Draft*;

WHEREAS, public comment was solicited, received and all persons wishing to be heard expressed their opinions regarding the aforesaid *Calvert County Transportation Plan, September 2019 Draft* and, at said December 18, 2019 hearing, the record was formally closed for public comment;

WHEREAS, pursuant to MD. CODE ANN., LAND USE § 3-203(c), copies of the aforesaid *Calvert County Transportation Plan, September 2019 Draft* were provided to adjoining jurisdictions, State units and local jurisdictions responsible for financing or constructing public improvements necessary for implementation, at least sixty (60) days prior to the aforesaid public hearing;

WHEREAS, on January 15, 2020, the Calvert County Planning Commission made a finding that the aforesaid *Calvert County Transportation Plan, January 2020 Draft* was consistent with the Calvert County Comprehensive Plan;

WHEREAS, upon consideration of all staff reports, all agency and local jurisdiction comments, comments of adjoining jurisdictions, comments of State units and public comments, written and oral, the Calvert County Planning Commission recommends that the *Calvert County Transportation Plan, January 2020 Draft* be adopted by the Board of County Commissioners for Calvert County and conveyed its recommendation by resolution; and

WHEREAS, on February 25, 2020, following publication of due notice, the Board of County Commissioners conducted a public hearing to consider the aforesaid *Calvert County Comprehensive Plan, February 2020 Draft.*

WHEREAS, public comment was solicited, received and all persons wishing to be heard expressed their opinions regarding the aforesaid *Calvert County Transportation Plan, February 2020 Draft;*

WHEREAS, upon due consideration of the comments of the public, staff, agency and local jurisdiction comments, comments of adjoining jurisdictions and comments of State units, and the recommendation of the Planning Commission, and in furtherance of the public health, safety and welfare, the Board of County Commissioners determined it is in the best interest of the citizens of Calvert County to adopt the Calvert County Transportation Plan as set forth in Exhibit "A" attached hereto and made part hereof; and

WHEREAS, the Board of County Commissioners met in public session on [month day], 2020, and determined to adopt the Calvert County Transportation Plan as recommended by the Planning Commission.

NOW, THEREFORE, BE IT ORDAINED by the Board of County Commissioners of Calvert County, Maryland that the Calvert County Transportation Plan, adopted March 10, 1998, by Resolution No. 10-98, is hereby repealed; and

BE IT FURTHER ORDAINED, by the Board of County Commissioners of Calvert County, Maryland that the Calvert County Transportation Plan, Exhibit "A" hereto, hereby is adopted as the official transportation plan for Calvert County; and

BE IT FURTHER ORDAINED, that this Ordinance shall take effect upon recordation.

DONE, this _____ of _____, 2020, by the Board of County Commissioners of Calvert County, Maryland, sitting in regular session.

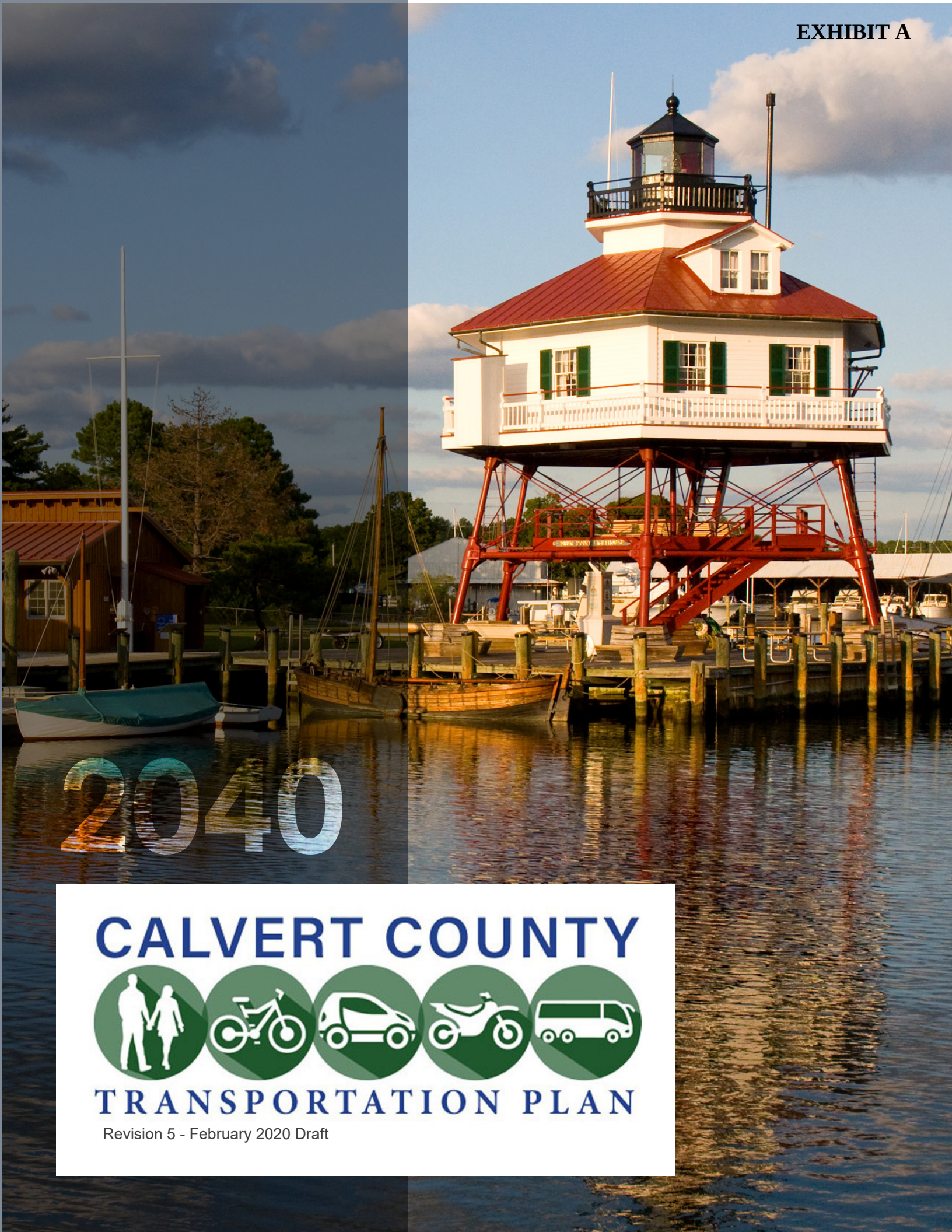
Aye: _____

Nay: _____

Absent/Abstain: _____

Add Signature Block for BOCC, Clerk, and County Attorney

EXHIBIT A



2040

CALVERT COUNTY TRANSPORTATION PLAN

Revision 5 - February 2020 Draft

Acknowledgments

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Earl F. Hance
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Carolyn Sunderland, AICP, Planning Commission Administrator

The Department of Planning & Zoning offers its sincere appreciation to many other county and state agency staff for their analysis, insight and review of the Comprehensive Transportation Plan:

Technical Advisory Committee
Department of Public Safety: Alfred Jeffrey, Deputy Director
Department of Community Resources: Sandra Wobbleton, Division Chief, Transportation
Sheriff's Office: Jason Dean, Deputy Sheriff Sergeant and Captain Dave Payne, Commander
Department of Economic Development: Kelly Robertson-Slagle, Director
Parks & Recreation: Shannon Nazzal, Director
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This Plan was prepared by Sabra & Associates, Inc., A Mead & Hunt Company
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Chris Killen | Creative Direction & Production

Table of Contents

List of Acronyms

AADT ..... Annual Average Daily Traffic

APF ..... Adequate Public Facilities

CTP ..... Consolidated Transportation Program

FEMA ..... Federal Emergency Management Agency

FY ..... Fiscal Year

IDZD ..... Intelligent Dilemma Zone Detection

LOS ..... Level of Service

MDOT ..... Maryland Department of Transportation

MDOT MTA ..... Maryland Department of Transportation Maryland Transit Administration

MDOT SHA ..... Maryland Department of Transportation State Highway Administration

MWCOG ..... Metropolitan Washington Council of Governments

NAS ..... Naval Air Station

TAZ ..... Transportation Analysis Zones

V/C ..... Volume to Capacity Ratio

LODES ..... Longitudinal Origin Destination Employment Statistics

Introduction and Executive Summary

Over a thirty-year period beginning in the mid-1980s, Calvert County's population grew by nearly 160% to 92,000 residents in 2018. This growth can be attributed to the always strong federal sector in the core of Washington, DC, Joint Base Andrews, Suitland, New Carrollton and other suburbs, and base realignment to the benefit of the Patuxent River Naval Air Station. Newcomers were willing to exchange a longer commute for Calvert County's high quality of life with easy access to the Chesapeake Bay and Patuxent River, low taxes and good schools.

During that time, Maryland Department of Transportation's State Highway Administration (MDOT SHA) widened portions of MD 2/4 and worked closely with the County on access management strategies to mitigate some of the stop-and-go traffic. MDOT's Maryland Transit Administration (MTA) grew its commuter bus ridership and park-and-ride capacity nearly tenfold. The County also implemented a growth management strategy that preserved rural areas and targeted Town Centers in Dunkirk, Owings, Huntingtown, Prince Frederick, St. Leonard, Lusby and Solomons for residential and commercial development.

Thirty years after the residential boom started, population growth has stabilized. Projections through 2040 indicate a rate of growth in Calvert County averaging 0.5% annually. While Calvert County's population growth has stabilized, its demographics and commuting patterns are changing rapidly. Baby boom retirements have reduced the number of persons in the workforce, but those who are working do so with a longer commute to a destination outside of the County.

Throughout the building boom, the county was developed in a typical auto-oriented suburban fashion with agricultural, commercial, residential and industrial areas generally separated through zoning practices. Beginning with the 1983 Comprehensive Plan, the county initiated a strategy that concentrated growth within Town Centers as the focal point of residential and commercial development. Still, the predominant mode of transportation in Calvert County is the personal automobile. More than 90% of county residents commute to work alone in their personal vehicle; fewer than 3% percent use public transit. Given the development pattern and the distance from major employment centers, there is no evidence that at a countywide scale these modal shares are likely to change. However, it is possible that development policies and transportation investments can shape the Town Centers with a balanced transportation network in certain corridors and smaller planning areas. The transportation focus of Town Center planning is to provide a local road network that keeps trips circulating without needing to use MD 2/4, and to create a pedestrian friendly environment that reduces the need for auto use for many trips within Town Centers.

Figure A - Calvert County in the Metropolitan Area.

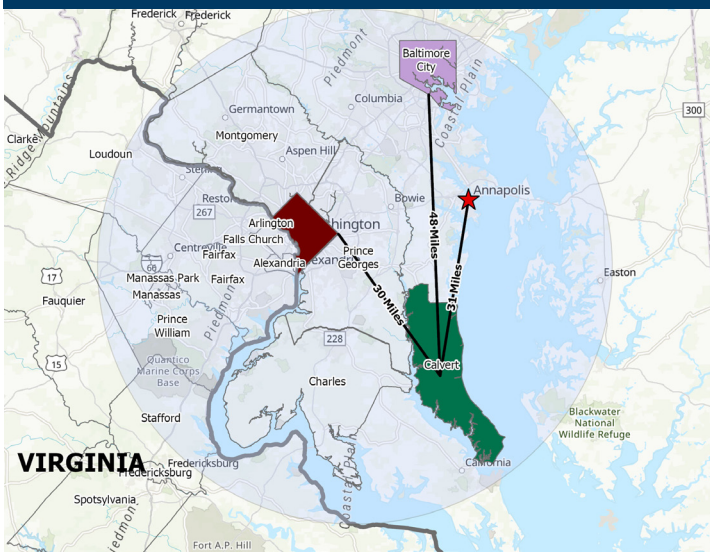


Table 1 - Transportation Characteristics 2009 vs 2017

Key Transportation Characteristics	2009	2017
Workers 16 Years or Older	45431	44872
Drive Alone	90.2%	90.1%
Use Public Transit	3.0%	3.0%
No Vehicle in Household	1.0%	1.5%
Work in County of Residence	41.1%	38.1%
Average Time to Work (minutes)	39.3	41.4
Greater than 60 Minute Drive	26.4%	29.0%

Source: U.S. Census Bureau, American Community Survey

Commuting and Traffic Conditions

The lack of major employers in Calvert County results in slightly more than 65% of commuting trips destined for locations outside of Calvert County. This phenomenon has steadily increased over the past three decades. Military facilities (Naval Support Facility Indian Head, Joint Base Andrews, Naval Air Station Patuxent River), defense agencies and contractors and non-defense federal agencies are the largest employment destinations for Calvert County residents. (See figure C.)

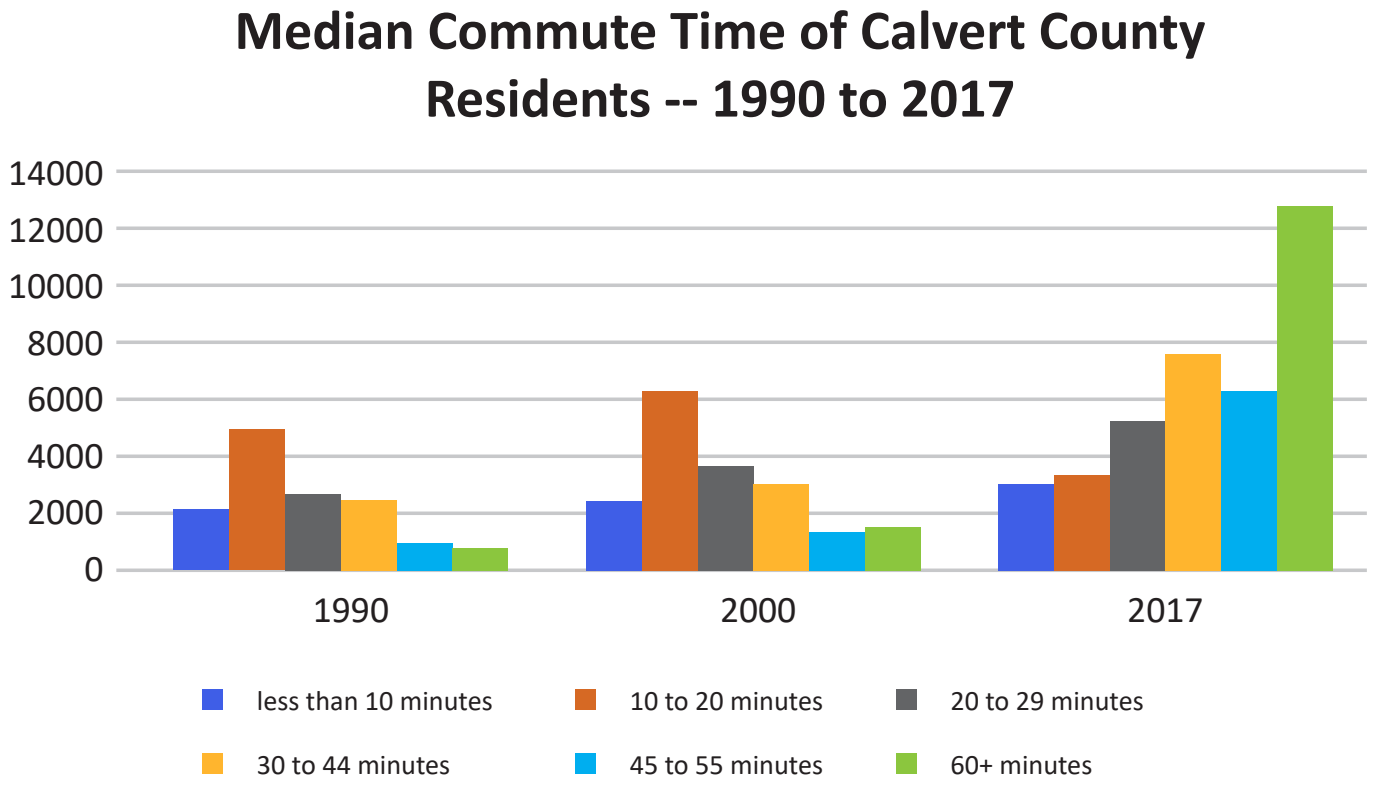
Fewer than 10,000 commuting trips are made into Calvert County each day. Nearly 50% of the trips made into Calvert County are by residents of Annapolis, southern Anne Arundel, Charles, and St. Mary's counties. (See figure D)

Finally, data[1] indicates that MD 2/4 carries a relatively insignificant amount of traffic from St. Mary's County across the Governor Thomas Johnson Bridge and through to Prince George's or Anne Arundel County. Fewer than 4% of all vehicles make this trip from the southern border through to the northern boundary of Calvert County. This is indicative of a strong economic relationship between Calvert County and NAS Patuxent River as 96% of all trips using the bridge are between Calvert and St. Mary's Counties. (See figure G)

Long Distance Commuters

As of July 2018, the Census Bureau estimates that the average commute time for a resident of Calvert County is 42 minutes, by far the longest average commute of any jurisdiction in Maryland. Maryland has the longest average commute of any state in the nation at 31.8 minutes. Long travel times are a function of increased trip length as people have moved to Calvert County from the metropolitan core and from traffic congestion on roads outside of Calvert County.

Figure B - Median Commute Time of Calvert County Residents-1990 to 2017



Source: U.S. Census Bureau, American Community Survey

[1] *Streetlight: Data for Mobility (proprietary data set), 2018*

Outbound Commutes from Calvert County

Figure C

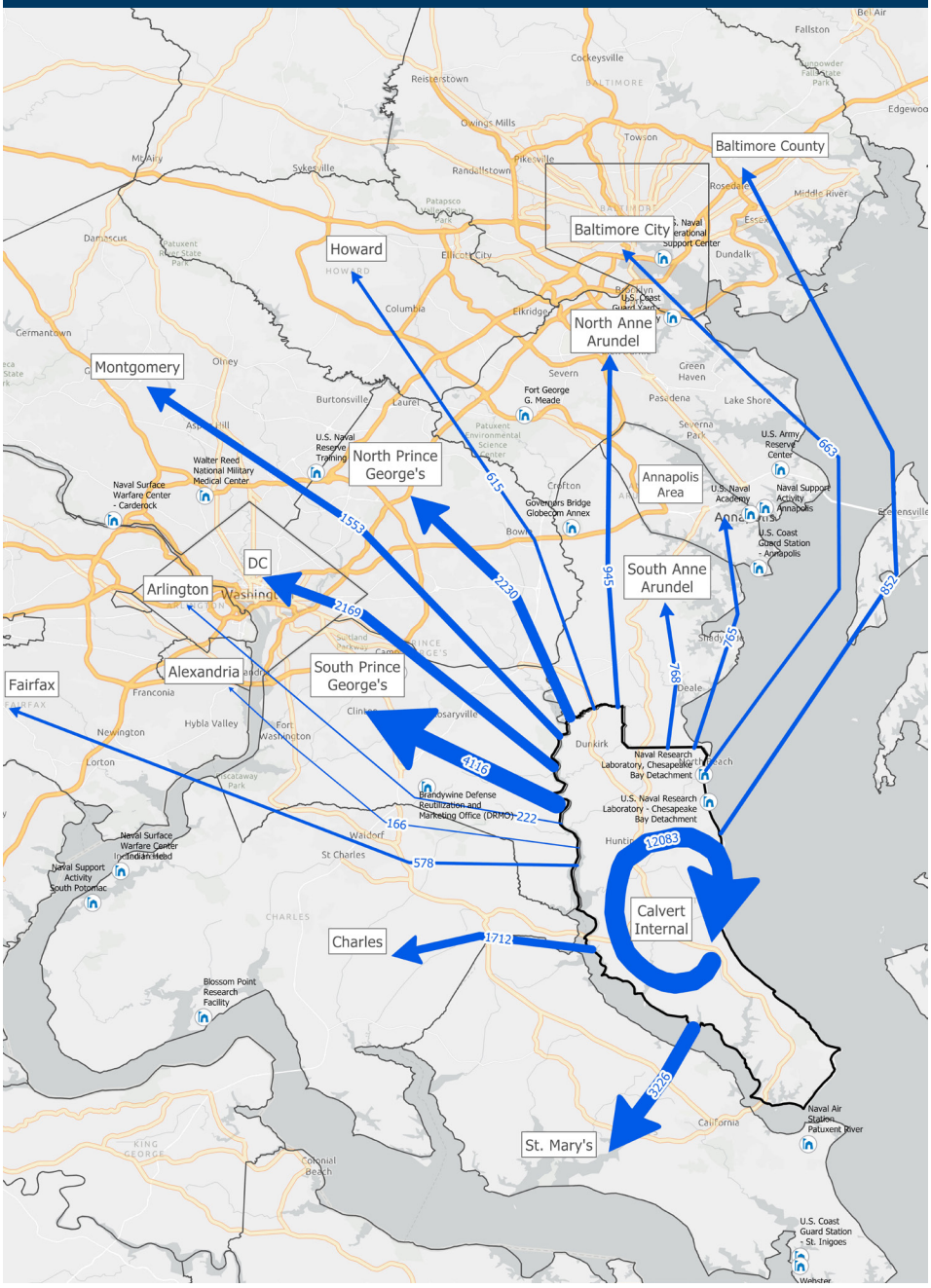


Table 2 - % of Workers from Calvert County to Surrounding Jurisdictions

Trip Origin	% of Trips
Calvert County	34.7
Southern Prince George's	11.8
St. Mary's County	9.3
Northern Prince George's	6.4
Washington, D.C.	6.2
Charles County	4.9
Montgomery County	4.5
Baltimore City/ Baltimore County	4.4
Northern Anne Arundel (BWI/Ft. Meade)	4.4
Annapolis/Southern Anne Arundel	4.4
All Other Locations	10.6

Source: U.S. Department of Labor, LEHD Origin-Destination Employee Statistics (LODES, 2017)

Inbound Commutes to Calvert County

Figure D

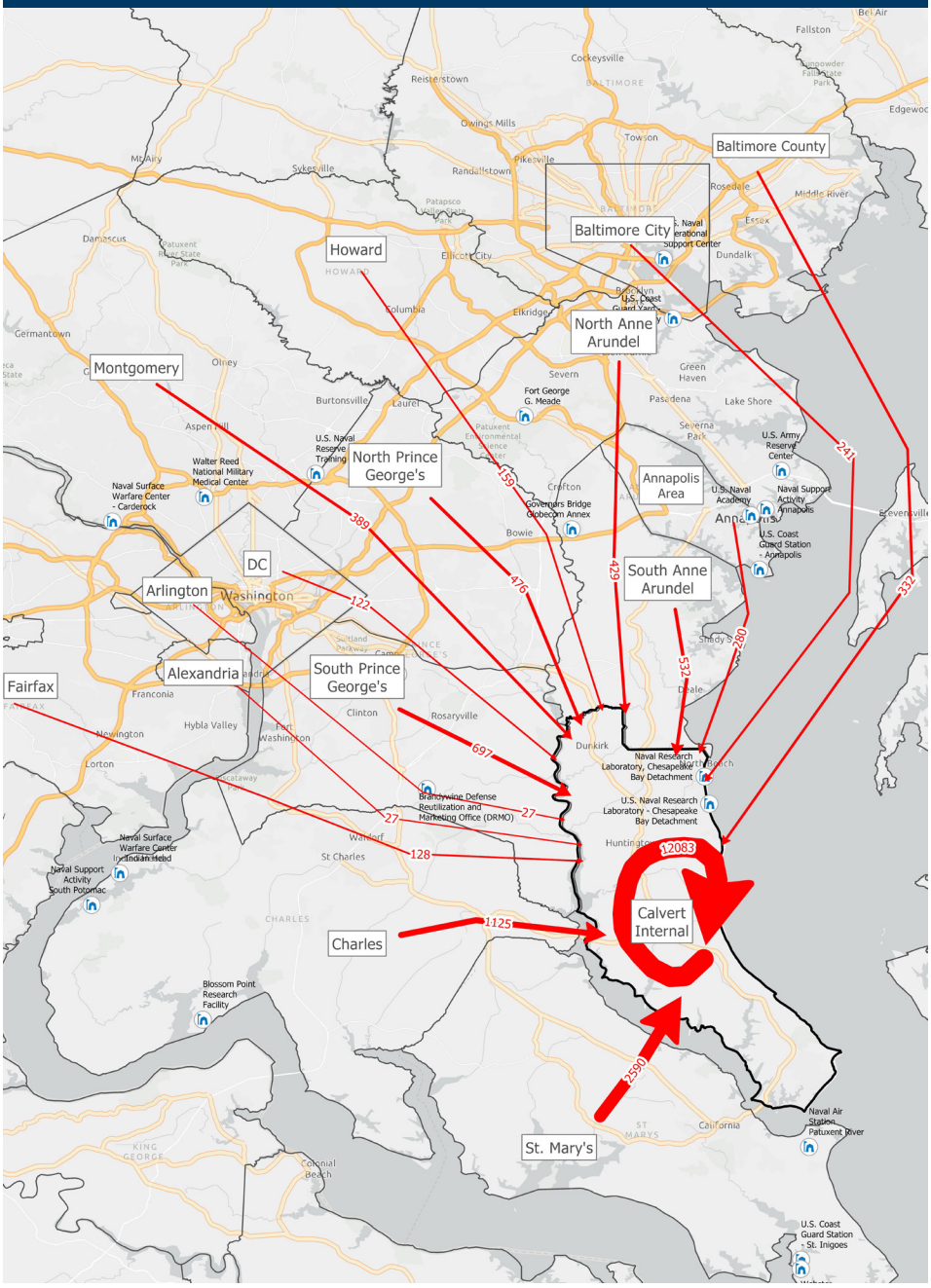


Table 3 - % of Workers Commuting to Calvert County by Jurisdictions

Trip Origin	% of Trips
St. Mary's County	28.3
Charles County	11.8
Annapolis/Southern Anne Arundel	8.9
Southern Prince George's	7.6
Baltimore City/County	6.3
Northern Prince George's	5.2
Northern Anne Arundel (BWI/Ft. Meade)	4.7
Montgomery County	4.2
Northern Virginia	2.0
Howard	1.7
Washington, D.C.	1.3
All Other	17.5

Source: U.S. Department of Labor, LEHD Origin-Destination Employee Statistics (LODES, 2017)

Traffic Changes Over Time

Annual Average Daily Traffic (AADT) along MD 2/4 ranges from 24,350 trips (bi-directional) near Cove Point to 41,000 trips in Prince Frederick. Most roads with two lanes in each direction (not inclusive of turning and acceleration/deceleration lanes) can carry approximately 50,300 - 56,175 trips daily[2]. This would indicate at a high level that MD 2/4 has the correct number of mainline lanes in each direction. (See Table 4 and Figure E)

Since 2010 when residential growth settled into a slow growth rate, there have been significant variations in traffic volumes on MD 2/4:

- Between Huntingtown (MD 263) and the MD 2/4 split, a modest 1.5% increase in Annual Average Daily Traffic (AADT.)
- Through Prince Frederick (MD 402 to MD 263), AADT dropped by 14.6% from 48,012 to 40,990. Some of this decline appears to be associated with the opening of Prince Frederick Boulevard in 2014 which now carries approximately 3,000 trips per day.
- Through Lusby and Solomons (from Coster Road/Mill Bridge Road to Lore Road), traffic increased by 11%.

Table 4 - 2017 Annual Average Daily Traffic

Segment	AADT
MD 4 (@ county line)	32,020
MD 4 (north of split)	29,500
MD 2/4 (approaching split)	39,330
MD 2/4 (Hunting Creek to Plum Point)	37,270
MD 2/4 (Plum Point to Dares Beach)	41,891
MD 2/4 (Dares Beach to Hallowing Point)	41,350
MD 2/4 (Hallowing Point to Sixes)	38,250
MD 2/4 (Sixes to Broomes Island)	36,740
MD 2/4 (Broomes Island to Truman Pkwy)	29,781
MD 2/4 (Truman Pkwy to Cove Point)	26,830
MD 2/4 (Cove Point to Rousby Hall)	24,350
MD 2/4 (Rousby Hall to Bridge)	28,470

Source: MDOT State Highway Administration

Figure E - 2017 Annual Average Daily Traffic

[2] *2013 Quality/Level of Service Handbook, State of Florida Department of Transportation*

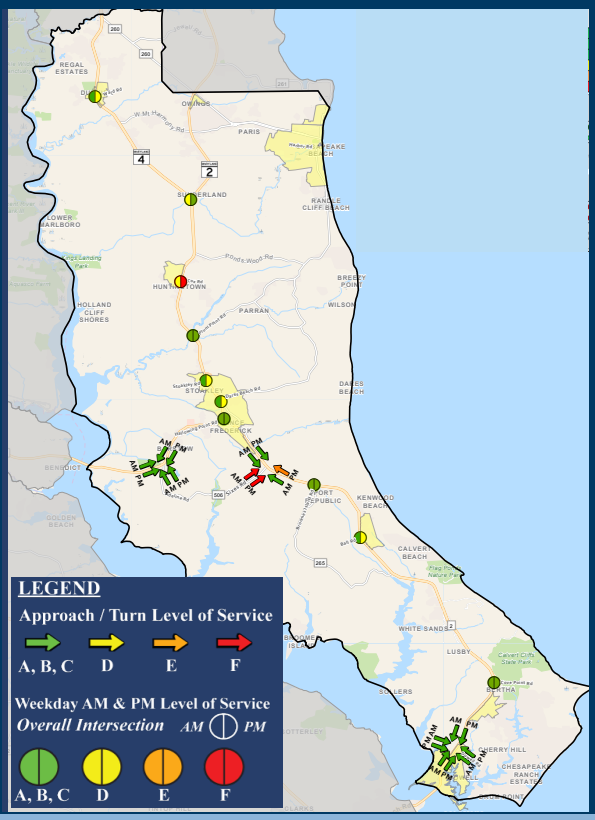
Current Road System Performance

On a countywide basis and when measured against objective industry standards[3], Calvert County's road system provides ample capacity for trips made by current residents and workers in the county. While there are hot spots of congestion at certain times of the day, overall the system operates very well.

All along the MD 2/4 corridor, morning peak hour[4] traffic speed consistently runs at or near the posted speed limit (50/55 mph in rural areas; 45 mph through the Town Centers). The same conditions occur in the PM peak hour, except through Prince Frederick where average speeds drop to under 30 mph between MD 263 and MD 402. Figure L1 and L2 depicts the AM and PM average travel speeds in Calvert County.

Like the traffic speeds, intersections along the MD 2/4 corridor also operate as intended with only Cox Road in Huntingtown operating at level of service (LOS) "F" during morning peak hour. LOS F indicates that traffic delay can be 80 seconds or more beyond the programmed signal cycle. All other intersections during the morning and afternoon peak hours operate at LOS "D" or better; MDOT SHA defines LOS "D" or better as being acceptable. Table 5 and Figure F depicts the intersection capacity and delay in Calvert County.

Figure F - 2019 Intersection Capacity and Delay



Source: Data collected by SAI, April 2019

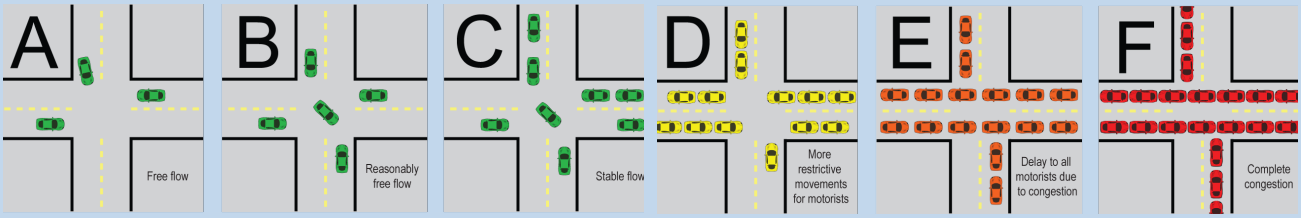
Table 5 - 2019 Intersection Capacity and Delay

Intersection	LOS (AM/PM)		Average Delay (sec)	
MD 4 @ Ward Road	C	D	26	48
MD 2/4 Split	D	C	39	28
MD 2/4 @ Cox Road	D	F	47	217
MD 2/4 @ Plum Point Road	C	B	25	17
MD 2/4 @ Stoakley Road	C	D	21	46
MD 2/4 @ Dares Beach Road	C	D	28	40
MD 2/4 @ Church Road	C	C	26	33
Adelina Road @ MD 231 (NB Approach)*	B	C	15	18
MD 2/4 @ Sixes Road (EB Approach)*	F	F	186	300+
MD 4 @ Broomes Island Road	B	B	12	12
MD 2/4 @ Calvert Beach Road	C	D	24	39
MD 2/4 @ Cove Point Road	B	C	13	25
MD 2/4 @ Dowell Road* (avg. all approaches)	C	B	8	9

** Unsignalized Intersection. Note: MD 2/4 intersection improvement opened in August 2019 is expected to return location to LOS B (AM) and B (PM)*

Source: Data collected by SAI, April 2019

Level of Service Key



[3] *The term "industry standards" refers to level of service, volume-to-capacity ratio, delay and other performance measures as defined by the Institute for Transportation Engineers.*

[4] *The term "peak hour" refers to that 60 minute period with the highest traffic volume. The peak period can vary by region, corridor, or roadway link. In Calvert County, the peak hour ranged from 6:45 AM to 8:05 AM. For the purpose of standardization within this analysis, the peak hour of 7:00 AM to 8:00 AM was used.*

Figure G - Traffic traveling through Calvert County

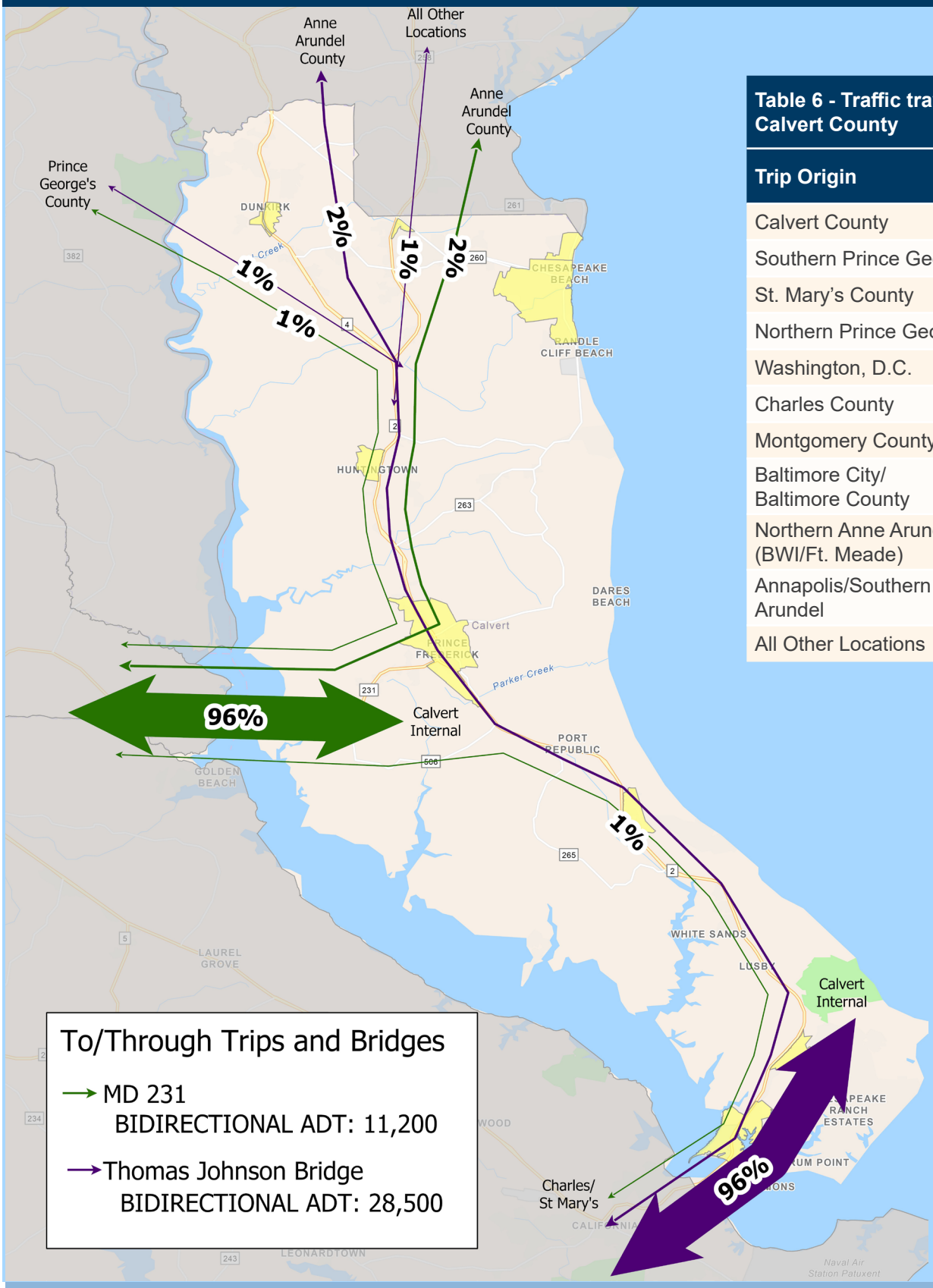


Table 6 - Traffic traveling through Calvert County

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Northern Anne Arundel (BWI/Ft. Meade)	4.4
Annapolis/Southern Anne Arundel	4.4
All Other Locations	10.6

Source: Data collected for SAI by Streetlight Data, Inc., April 2019

Transportation Choices

For nearly all residents of Calvert County, mobility is almost exclusively by automobile. 90% of all commuting trips are made by individuals driving alone and 3% of all residents don't commute, they work at home. The remaining commuters carpool or use public transit, specifically MDOT MTA commuter buses to Washington, DC. Commuter bus service has been tremendously successful. Using LODES data to establish the actual number of trips each to Washington, DC, it is estimated that as many as 40% of all commuting trips taken to Washington, DC by Calvert residents are by way of commuter bus. Other than limited service to the Federal Center at Suitland, no other commuter routes serve other parts of Maryland or Northern Virginia.

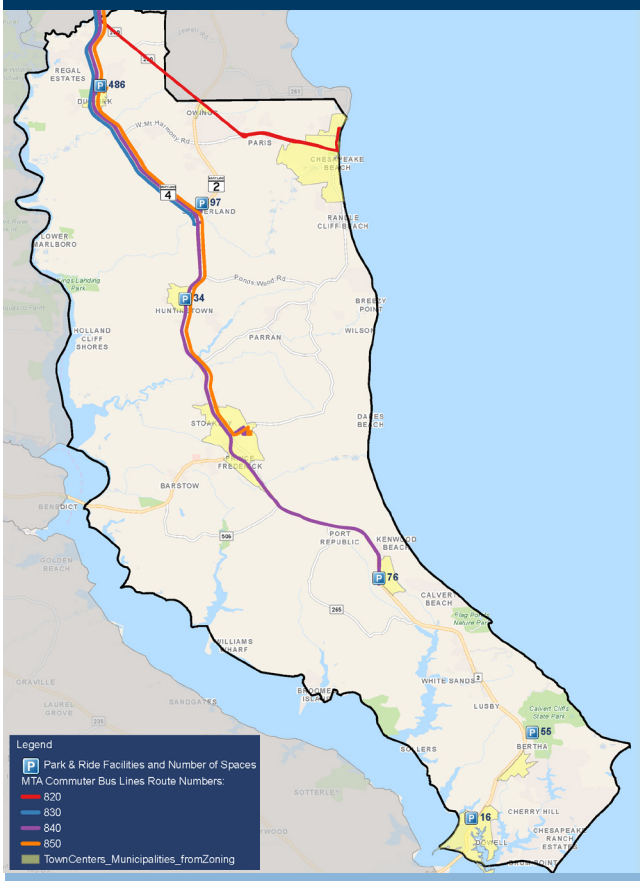
Table 7 - Commuter Bus Service to Washington, DC

	First Departure	Daily Trips	Average Riders/Day
810 Pindell	5:05 AM 3:00 PM	5	197
820 North Beach	5:14 AM 12:15 PM	9	902
830 Dunkirk	4:55 AM 2:40 PM	13	598
840 St. Leonard	4:35 AM 3:00 PM	5	424
850 Suitland	4:30 AM 3:00 PM	5	186
TOTAL		37	2,307

Source: MDOT Maryland Transit Administration, 2018

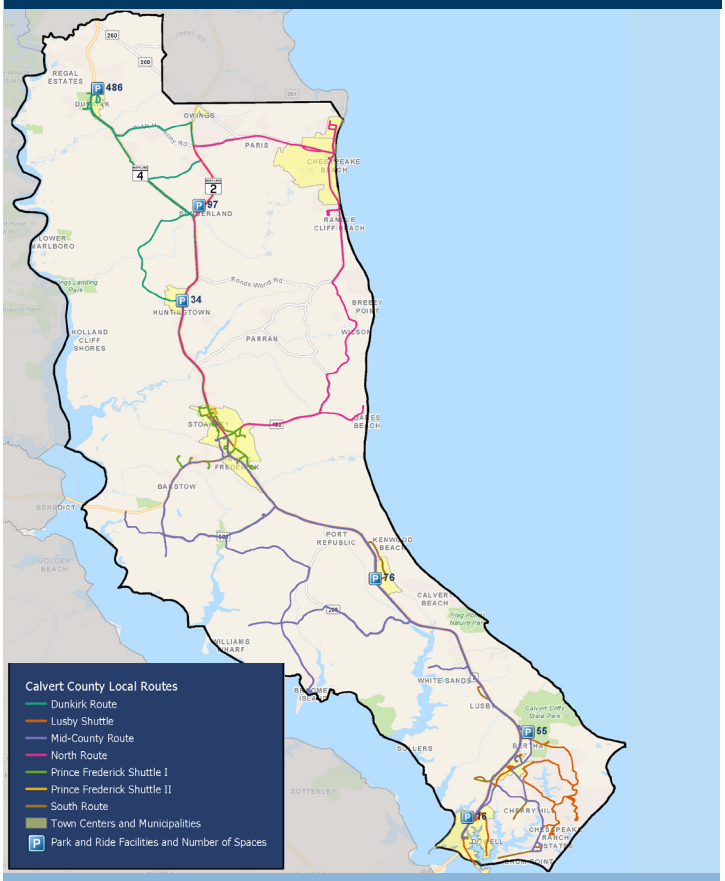
For the mobility-impaired or households with no vehicle, getting to and from work, health care services, the grocery store and other activities of daily life can be a major challenge. The Calvert County Department of Community Resources operates bus service on eight routes shown in map and table below and focuses mainly on providing access to shopping centers, medical facilities and other public services in the Town Centers. The bus system is run on a "flag system" which means there are few established bus stops and buses can be hailed along the route by passengers. Bus service operates on weekdays every 90 – 120 minutes between 7 a.m. and 9 p.m.; and very limited service on Saturdays.

Figure H1 - Commuter Bus Service to Washington, DC



Source: MDOT Maryland Transit Administration

Figure H2 - Local Bus Routes



Source: MDOT Maryland Transit Administration

Finally, travel on foot or by bicycle is extremely difficult and thus represents a tiny percentage of all trips in the county. Although improved over the past decade, there are significant gaps in the sidewalk network throughout the Town Centers. Sidewalk gaps result from long ago policies that did not emphasize pedestrian connectivity. This will improve as development occurs, but significant public investment will be needed to close many of the gaps. While sidewalks and bicycle facilities are an important aspect of making Town Centers successful, it cannot be reasonably expected that trips on foot or bicycle will ever result in reduced traffic congestion in Calvert County. Like transit services, sidewalks and bicycle lanes simply provide a choice in how to move around within parts of Calvert County, especially within the Town Centers.

Figure I - Sidewalks in Dunkirk (See Pages 28-33 of Appendix for other Town Centers)

Source: Data collected by SAI, April 2019

Transportation Challenges

Every county and region has its unique transportation challenges. Metropolitan areas have very high rates of traffic congestion and traffic crashes affecting broad swaths of the region. Rural communities have more isolated traffic congestion problems of more limited duration and have few practical transportation choices and services for the mobility impaired. As Calvert County looks ahead to 2040, it is important to report on these challenges in the context of what else is happening throughout the state.

Most of the major roadways in Calvert County are owned by the state of Maryland. When compared to the Metropolitan areas, traffic growth and congestion in Calvert County is very modest, and the cost-benefit ratio of significant construction improvements by MDOT SHA in Calvert County is quite low. As such, Calvert County has seen (and will likely continue to see) relatively little state investment in new road capacity, with the exception being the widening of MD 2/4 through Prince Frederick. Initially developed as a two-phase project (one north and one south of MD 402), the project has now been chopped into several very short segments which would be constructed over the next twenty years. The slowing of the MD 2/4 project is symptomatic of a federal transportation funding system that isn't working and a state funding mechanism that can't keep up with Maryland's transportation needs.

Calvert County is hardly in any position to fill the gap between roadway needs and available resources. While conservative fiscal management has allowed the County to maintain a sound financial position and a AAA bond rating, investments in new transportation infrastructure have been limited. Over the past decade, County capital budgets allocated the greatest share of resources to education ($90 - $110 million annually) and public safety ($40 - $60 million annually) while investments in new transportation capacity have averaged less than $4 million annually. In the FY20 operating budget, the Board of County Commissioners made a significant investment in road paving at $6 million which begins to address the backlog of road repair needs. While more can always be done by local and state government, developers and others, Calvert County appears to have struck a proper balance between the public service needs and concerns of its residents.

Still, there are challenges in the transportation system and how it will evolve over the next twenty years will depend on the setting of policy and funding priorities. These are the most prominent challenges to be considered as the County looks forward.

Traffic Safety

Between 2015 and 2018, there were just under 4,400 traffic crashes in Calvert County – an average of four per day. (By way of comparison, Anne Arundel County experiences nearly 30 traffic crashes per day.) While this is a relatively low rate of occurrence locally, traffic safety nationally has become a public health crisis. Not surprisingly, the preponderance of traffic crashes is along MD 2/4 and specifically in or approaching the Town Centers. None of these crashes involved fatalities although serious injuries and property damage has occurred. The first southbound signalized intersection along the high-speed section of MD 4, MD 2/4 split and the intersection of MD 262 are of concern as numerous serious crashes have occurred, including three fatalities (including one pedestrian).

While many traffic crashes are a result of routine human error and can be mitigated with physical improvements, certain risky and antisocial behaviors have been identified as a concern as well. Calvert County has the second highest per capita rate of crashes involving motorcycles and sixth highest per capita rate of alcohol or drug impaired crashes in the state. St. Mary's County has very similar crash rates in both categories.

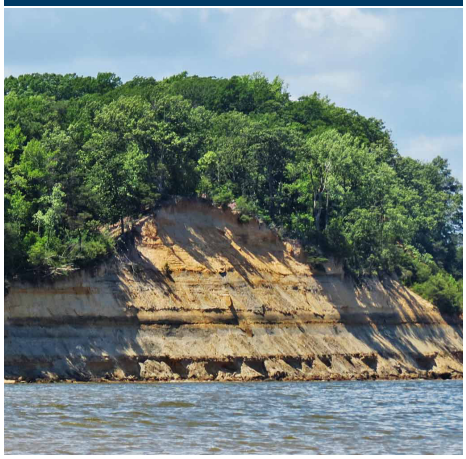
Vehicles running off the road are one of the leading causes of traffic crashes in Calvert County.

Geography & Environmental Constraints

Calvert County is a long narrow peninsula bounded by the Patuxent River to the west and the Chesapeake Bay to the east and south. MD 2/4 is the only arterial which runs the full north-south span of the County which can be a particular safety concern during times of evacuation or when an accident occurs on MD 4 between Dunkirk Town Center and MD 495. The Thomas Johnson Bridge crosses the Patuxent River to the south into St. Mary's County. Prince George's and Anne Arundel Counties are to the northwest and northeast, respectively. One bridge crosses the Patuxent River to Charles County two-thirds of the way south of the northern county boundary. Several state roadways branch east and west from the MD 2/4 spine and are supported by a local network of collectors and minor arterials connecting further to the interior.

Other than building loop roads, realigning some roadway sections and completing planned connections, there isn't much room for new roads in Calvert County. Where opportunities might exist, environmental challenges such as steep slopes, protected forest and agricultural lands, and sensitive wildlife habitats would be difficult to overcome.

Calvert Cliffs State Park



Aging Populations and Mobility Challenged

Significant implications for mobility arise from a population that is aging or unable to drive a vehicle, most specifically access to social networks, health care and healthy foods. While advanced age and attendant health concerns (declining vision and hearing, for example) are not always limiting factors in mobility, they are certainly a significant constraint for many. More than 25% of Calvert County residents are age 65 or older – a seven-fold increase since 1990. The County's transportation system has not fundamentally changed to serve this demographic. Calvert County should address this need as a matter of public health and safety.

Transportation Technologies

MDOT SHA has implemented several technologies in the areas surrounding Calvert County but has only limited deployments within Calvert County. Currently, MDOT SHA maintains three video monitoring cameras: MD 260 at Cox Road in Chesapeake Beach, and two at the bridge crossings of the Patuxent River (MD 4 and MD 231). Further north, MDOT SHA has implemented the Smart Signals program on MD 2 approaching Annapolis and dynamic message signs and traffic monitoring cameras along US 301 through Anne Arundel and Prince George's Counties.

One limitation on MDOT SHA's ability to deploy transportation technology solutions in Calvert County is the limited communications infrastructure such as fiber optic lines which enhance the ability to implement additional video cameras, gather real-time data, operate dynamic message signs and implement real-time traffic signal control. These limitations will become more apparent as the number of connected vehicles using communications devices to convey and share information grows and as Connected and Automated Vehicle technology improves and expands.

Table 8 - Ranking of highest probability hazards for Calvert County

Hazard	Rank
Flood	1
Coastal Storm Wind	2
Tornado	3
Severe Thunderstorm	4
Lightning	5
Earthquake	6
Winter Storm	7
Extreme Temperatures	8
Hail	9
Drought	10

Source: Calvert County All Hazards Mitigation Plan, June 2017

Climate Change & Infrastructure Resiliency

Increasing tidal activity and severe storms are causing more roads to flood than ever before; thirty roads have experienced recent or recurring flooding since 2018. Floods are generally the result of excessive precipitation and can be classified under two categories: general floods, precipitation over a given river basin for a long period of time; and flash floods, the product of heavy localized precipitation in a short time period over a given location. The severity of a flooding event is determined by the following: a combination of stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and the degree of vegetative clearing. A variety of strategies are used to combat flooding depending on the frequency, cause and extent of the flooding.

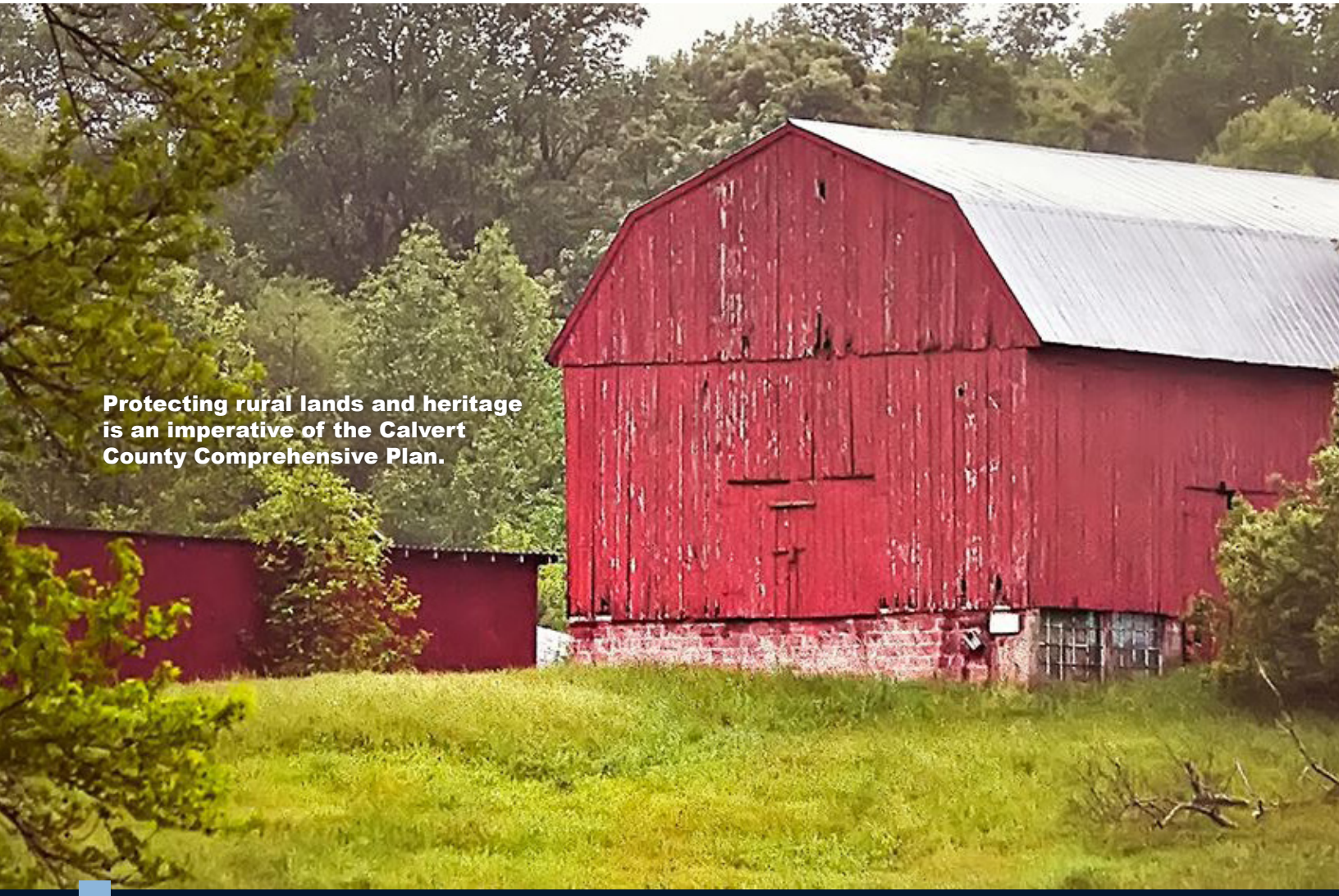
Dispersed Travel Patterns and Lack of Trip Density

While Calvert County has been successful in preserving its rural and agricultural character over the past forty years – even in the face of significant growth in the 1980s and 1990s – development patterns are dispersed such that there is an insufficient number of commuting trips to locations outside of the county. Even if there was a very strong interest from Calvert residents to use a commuter bus service to the state government complex in Annapolis, for example, the total number of commuters to Annapolis is still very small and may not be enough to justify the public investment.

Calvert County has been more successful in meeting its Comprehensive Plan policies of farm and forest preservation than it has in creating vibrant Town Centers. While coming close to meeting the 2010 Comprehensive Plan goal of 35 percent of new households locating inside or within one mile of the Town Centers, Calvert County has not achieved the desired development patterns. The dispersion of residential growth has made it difficult to coordinate and implement transportation improvements that benefit the entire network.

Coordinating Land Use, Growth, and Infrastructure Investments

The County's Adequate Public Facilities (APF) regulations establish a broad process whereby developers are required to mitigate specific traffic conditions to a level of service standard which varies by roadway type and development location. Rather than a coordinated system of improvements as defined in a corridor plan, developers instead build a turn lane or deceleration lane that specifically benefits their new subdivision rather working together with the County to meet a greater need in the development corridor. Tools such as "fee-in-lieu" of location-specific traffic mitigation improvements can be used to create larger-scale road improvements that reduce bottlenecks over a greater area than can be accomplished by one development.



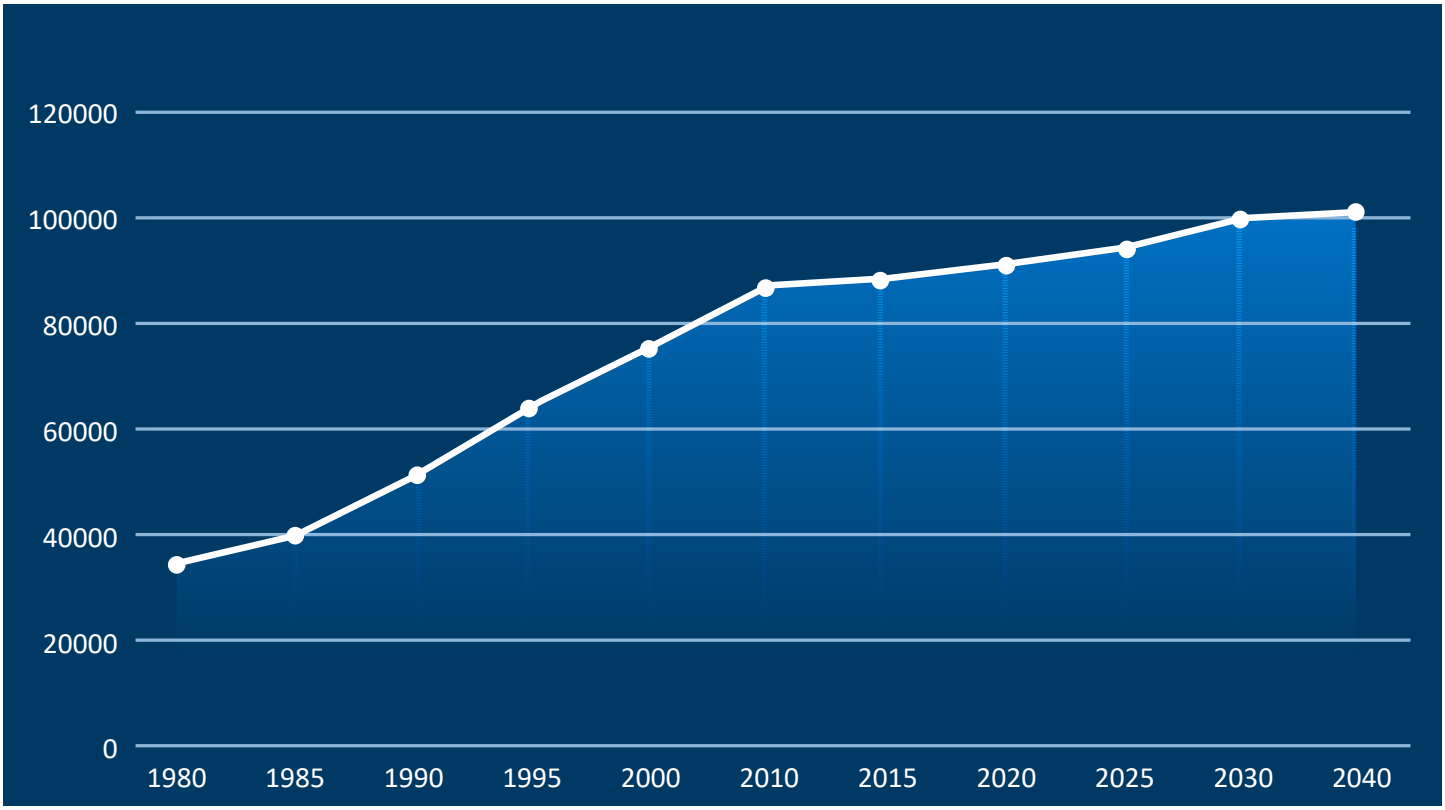
Protecting rural lands and heritage is an imperative of the Calvert County Comprehensive Plan.

The Road Ahead: Forecasting Travel Demand through 2040

Implementation of previous Comprehensive Plan policies has contributed to reducing the county's growth rate for both population and households, which has continually decreased since its peak in the 1970's. Over time, Calvert County has gone from being the fastest growing county in Maryland to one of the slowest in the metropolitan areas. The population growth rate is projected to continue to slow in the future and translates into a reduced growth of households and demand for additional housing units as shown in the following table.

As residential growth has slowed, so too has the growth in traffic volume; however, it can be fairly argued that the transportation infrastructure was never fully built to support the population boom. Accordingly, there are bottlenecks along MD 2/4 and excessive delay occurs at a few intersections which need to be resolved through a variety of traffic operations and road capacity solutions. Forecasting travel demand through 2040 allows state and county planners to objectively evaluate future traffic conditions and to develop and prioritize cost-effective solutions to achieve reasonable and reliable commuting times.

Figure J - Calvert County Actual and Forecasted Population: 1980 - 2040



Source: American Community Survey; Maryland Department of Planning

Scenario-Based Forecasting

Until the past decade or so, the development of county and small area transportation plans has been based on single forecasts of future population, households and employment pegged to a horizon year; however, growth patterns and intensity are influenced by multiple factors: environmental features, the existing transportation network, available utilities, local policies and market conditions. As travel demand data and modeling tools have become more accessible and efficient, it has become easier to prepare and analyze multiple forecasts which evaluate the influence of development intensity and land use patterns on transportation systems.

Based on the potential for development in consideration of protected agricultural lands and forested areas and the prohibition of new septic systems in subdivisions under the State's Sustainable Growth and Agricultural Preservation 2012, three growth scenarios were tested to better understand how the pace and scale of growth would affect the transportation network. Town Center land uses and boundaries of the Comprehensive Plan adopted in 2019 were used as the baseline.

Enhancing the Travel Demand Model

The travel forecasting model used for the Calvert County Transportation Plan is the Metropolitan Washington Council of Governments (MWCOG) Version 2.3.75 adopted on October 17, 2018. As Calvert County is not a core jurisdiction of MWCOG, the model gives little consideration to land use, environmental factors, and development capacity that is specific to Calvert County. The model also uses broad transportation analysis zones (TAZ's) which make detailed analysis difficult at the Town Center level.

To establish a reliable travel demand forecast for 2040, the model was enhanced specifically for Calvert County by:

1. Increasing the number of transportation analysis zones from 46 to 66 thereby allowing for a more fine-grained investigation, especially in the Town Centers.
2. Removing environmentally sensitive areas such as forested lands and steep slopes as potentially developable parcels.
3. Accurately allocating future development capacity (which translates to population, households and employment) to the TAZ's.

Scenario 1: Historical Growth Rate: This scenario uses household growth rate between 2010 and 2017 as reported by the United States Census to project household growth until 2040. Based on these seven years, households can be expected to increase by 12.5% by 2040 to a total population of 101,737. This rate is slightly higher than the forecast by the Maryland Department of Planning which projects 100,450 residents by 2040.

Scenario 2: Aggressive Growth: This scenario projects significantly a 50% growth in households throughout the county through 2040. This growth rate resembles market conditions like the period from the mid-1980s through 2010. During this time period, the county population increased from approximately 34,000 to approximately 88,000 residents.

Scenario 3: Hyper Growth: The scenario projects a maximum build-out by 2040 of all developable residential parcels even when including environmental constraints and growth management programs such as transferable development rights currently in place. A 91.8% household occupancy rate was applied to all buildable residential parcels. This would add approximately 75,000+ residents to Calvert County beyond the population forecast in scenario #1 (historical growth rate).

Table 9 - Projected Population, Housing and Employment Growth Under Three Scenarios

This chart shows all options considered during the planning stages of the plan. Aggressive and Hyper growth are not the basis for the plans strategic transportation policy and investments for Calvert County. These two scenarios are what the County is trying to avoid.

	2017	2019 Plan Historical Growth (2040)	2019 Plan Aggressive Growth (2040)	2019 Plan Hyper Growth (2040)
Households	33,064	35,198	50,642	61,478
Population	93,228	101,737	145,752	176,636
Employment	35,120	35,562	40,784	53,222

Source: Data developed by SAI using models from the Metropolitan Washington Council of Governments and the Maryland Department of Planning

Traffic Conditions Under Most Likely Growth Scenario

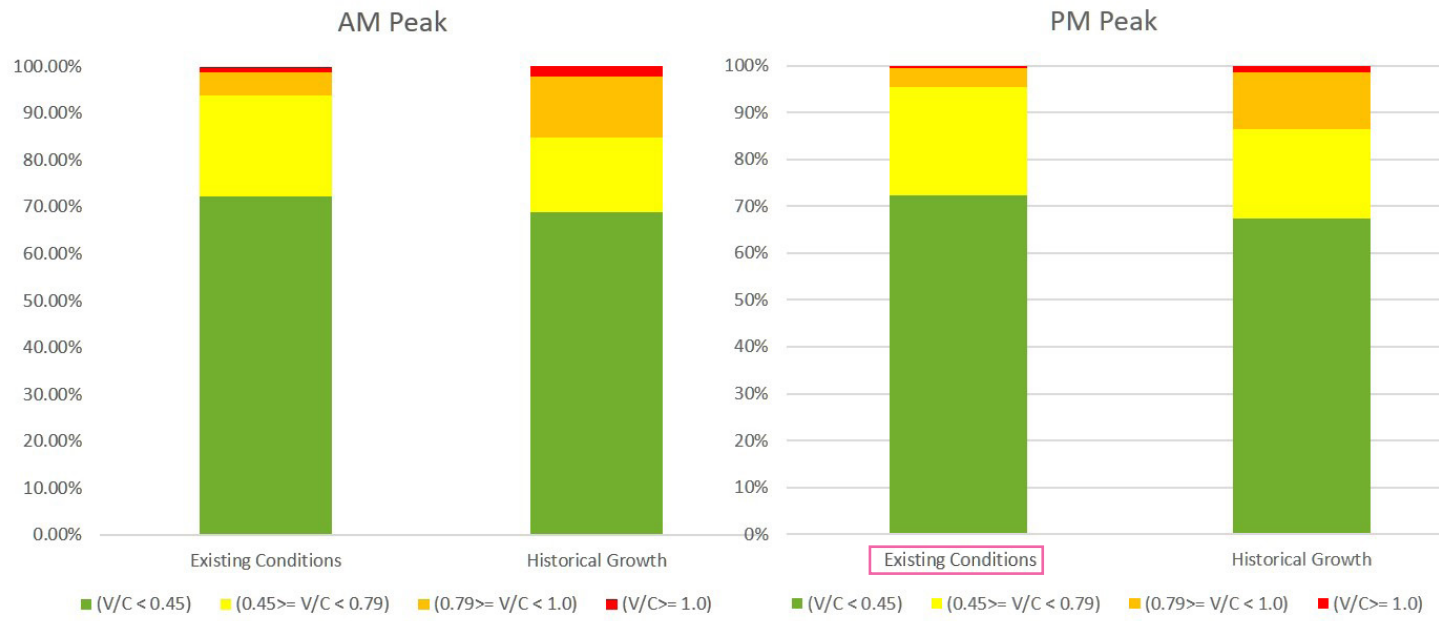
Given market conditions, demographics and distance from the metropolitan areas, the most likely scenario is that Calvert County grows on average by .5% percent per year – or 12.5% over the next twenty years. This rate is slightly higher than but consistent with the 2020 – 2040 growth rate in the 2019 Comprehensive Plan, and the 2020 – 2040 growth rate forecasted by the Maryland Department of Planning.

Systemwide Traffic Speed and Congestion Analysis

The MWCOG travel forecasting model takes into consideration improvements which can reasonably be expected to be constructed through 2040. Two state-funded projects are included: completion of the full MD 2/4 widening through Prince Frederick and widening of the Thomas Johnson Bridge from two to four lanes. A third improvement, completion of Fox Run Boulevard, would be funded locally.

With these improvements made by 2040, there is a very slight overall change in the systemwide directional miles which are congested. In the AM peak, only 2.33% miles exceed capacity vs. 1.08% which exceed capacity in 2017. (Even under an aggressive growth scenario, only 4.14% directional miles would exceed capacity.) In the PM peak period, only 1.39% of all directional miles would exceed capacity in 2040 vs. 0.59% which exceed capacity in 2017. (Again, even in an aggressive growth scenario only 3.47% directional miles would exceed capacity.) As in the current (2017) condition, on a countywide basis when measured against objective industry standards, Calvert's road system in 2040 provides ample capacity for trips made by the forecasted number of residents and workers in Calvert County. That is not to say that there aren't or won't be hot spots of congestion at certain times of the day, but overall the system operates very well.

Figure K - Volume to Capacity Ratio on State Roads and Primary County Roads
AM Peak Hour (7am - 9am / PM Peak Hour 4 pm-6pm)



Road segments calculated state roads: MD 2/4, MD 231, MD 506, etc. and major county-owned roads (Cox Road, Ponds Woods Road, etc.) equate to approximately 25% of all road mileage in Calvert County. For reference, see 2017 Maryland Highway Mileage Report from MDOT SHA.

Source: Data developed by SAI using Cube software by CitiLabs. Cube is a regional travel demand model.

Figure L1 - 2017 AM Volume-to-Capacity

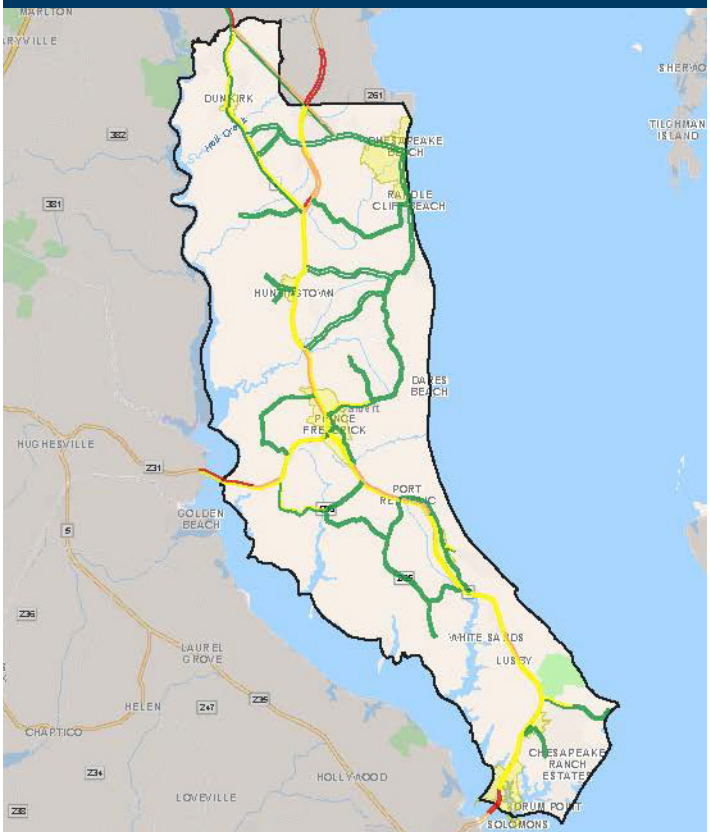


Figure L2 - 2017 PM Volume-to-Capacity

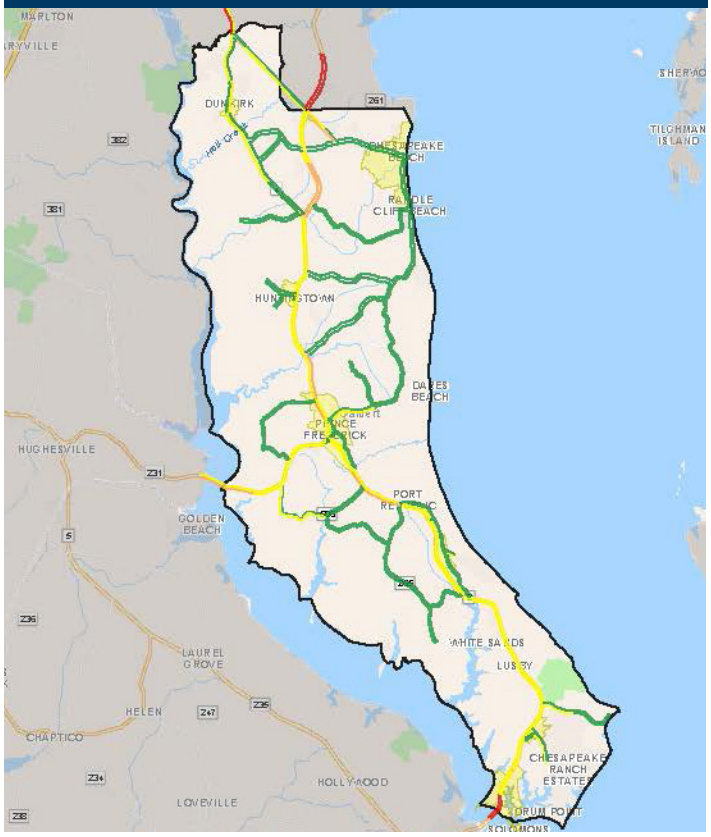


Figure L3 - 2040 AM Volume to Capacity at Historical Growth Rate

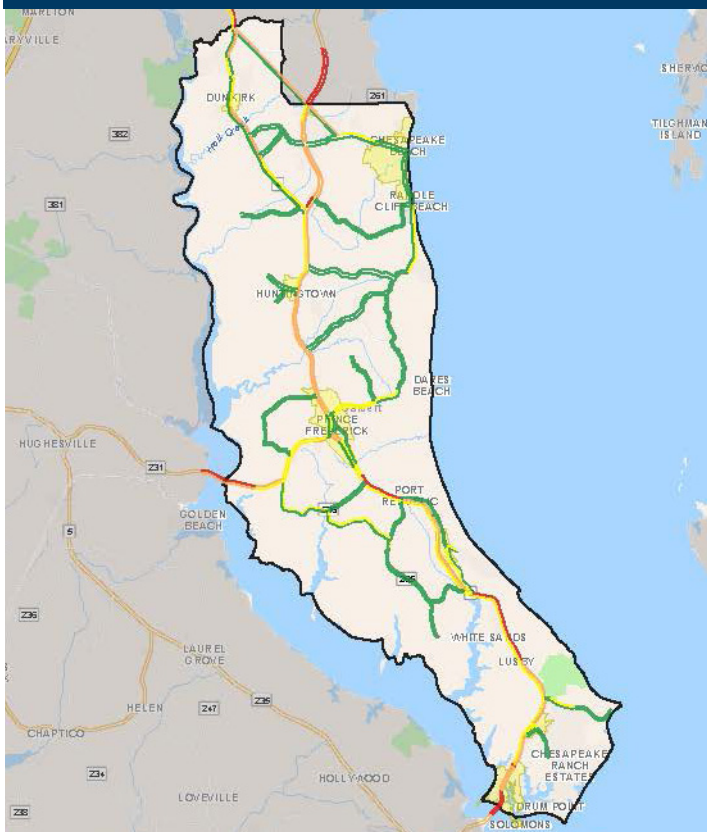
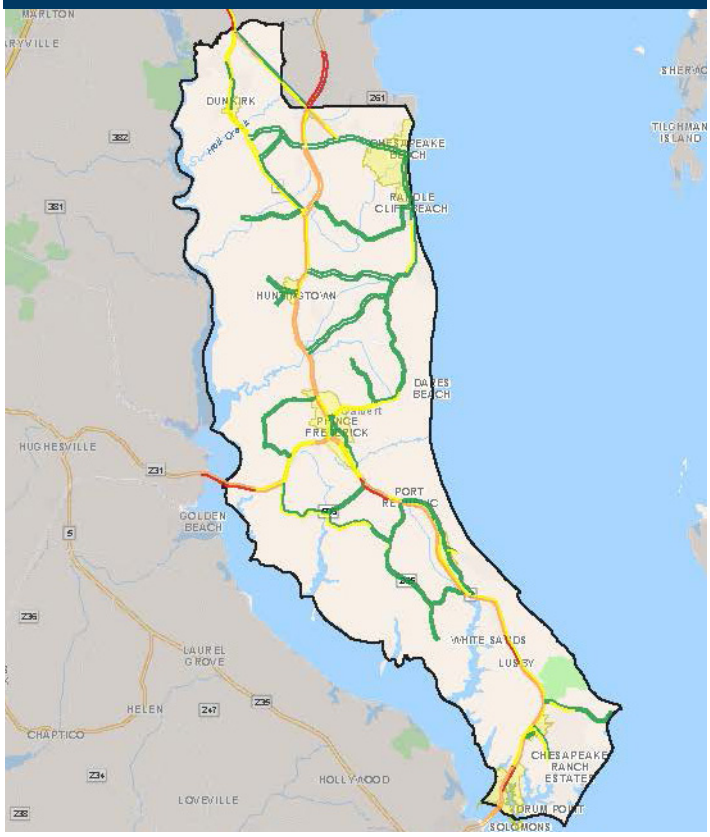


Figure L4 - 2040 PM Volume to Capacity at Historical Growth Rate



Localized Congestion in 2040

As indicated above, there are congestion hot spots forecasted for 2040 within the county. These hot spots occur in the Town Centers and can be mitigated with spot improvements. When operational improvements are made to these intersections (as recommended in the plan under Goal #4), intersection level of service returns to acceptable conditions in most cases. More aggressive solutions may be needed at MD 2/4 at Cox Road and MD 2/4 at Dowell Road.[5]

Table 10 - Intersection Level of Service Comparison

Intersection	2017		Historical Growth with MWCOG Improvements*		Historical Growth with MWCOG + Additional Improvements	
	AM	PM	AM	PM	AM	PM
MD 4 @ Ward Rd	C	D	C	E	C	E
MD 2/4 Split	D	C	E	D	E	D
MD 2/4 @ Cox Rd/MD 524	D	F	F	F	D	F
MD 2/4 @ Plum Point Rd/MD 263	C	B	C	B	C	B
MD 2/4 @ Stoakley Rd	C	D	D	F	C	E
MD 2/4 @ Dares Beach Rd/MD 402	C	D	E	F	C	E
MD 2/4 @ Hallowing Point Rd/MD 231/Church St	C	C	C	D	C	D
Adelina Rd/MD 508 @ Hallowing Point Rd/MD 231	B	C	C	D	C	D
MD 2/4 @ Sixes Rd/MD 506 (E/B Approach)	F	F	A	C	A	C
MD 4 @ Broomes Island Rd/MD 264	B	B	B	B	B	B
MD 2/4 @ Calvert Beach Rd	C	D	C	D	C	D
MD 2/4 @ Cove Point Rd	B	C	B	D	B	D
MD 2/4 @ Dowell Rd/Monticello Dr*	C	C	D	F	D	F

**MWCOG Improvements refer to new road capacity projects built into the 2040 travel demand model. Two projects are included: widening of the Thomas Johnson Bridge from 2 to 4 lanes, and , improvements to MD 2/4 at Dowell Road, widening of MD 2/4 through Prince Frederick from 4 to 6 lanes, and completionof Fox Run Boulevard.*
Data developed by SAI using SYNCHRO traffic analysis software. SYNCHRO is a level of service software model for specific intersections or road links.

There are many tools available to transportation planners to improve the level of service (and safety) at congested intersections. Each tool has its own costs and benefits which can only be fully described in the context of planning a specific improvement.

Table 11 - Summary of Traffic Capacity & Management Improvement Tools

Improvement Type	Cost	Time to Implement	Benefit
Grade Separated Interchange	Very High	7-10 years (min)	Reduce mainline delay, improve reliability and safety
Roadway Widening	High	5-7 years	Reduce mainline delay
Access Management	Low	1-2 years	Reduce mainline delay and improve safety
Intersection Approach/Turn Lanes	Low	1-2 years	Reduce turning delay
Traffic Monitoring/Signal Timing	Very Low	2-6 months	Improve reliability and reduce delay
Traveler Information Systems	Moderate	1-2 years	Alternate routing
Commuter Transit	Low	6 months-1 year	Choice

[5] *Improvements to MD 2/4 at Dowell Road are assumed to be included with widening of the Thomas Johnson Bridge from 2 to 4 lanes.*

The Plan: Strategic Transportation Policies and Investments for Calvert County

Goal 1: Build and maintain transportation assets that are safe, resilient, and in good repair.

The County's first responsibility is to keep its assets safe and well maintained. The most obvious (and most expensive to maintain) transportation assets are roads and bridges; culverts and stormwater management facilities, fences and guardrails, signs, transit vehicles and maintenance facilities are also part of the asset inventory. The county's operating and capital budgets have usually given priority to maintenance and safety, although there is always more to be done. A lifecycle asset management approach will provide the county with a solid foundation from which to monitor the transportation system and optimize the preservation, upgrading, and timely replacement of transportation assets through cost-effective management, programming, and resource allocation decisions. It is a systematic process of maintaining, upgrading, and operating physical assets cost-effectively, throughout their lifecycles.

Objective: Calvert County's roads, bridges, and culverts will be maintained in a state of good repair as established by local standards.

Strategies:

- Establish a full condition inventory of the County's roads, bridges and culverts in Calvert County and define appropriate maintenance standards for each type of road, bridge and culvert.
- Develop a reasonable lifecycle maintenance plan for county collector and arterial roads.
- Allocate and program operating and capital maintenance resources for roads, bridges and culverts based on the risk to public safety and the economy. Risk should consider, at a minimum, traffic volume, safety record, structural condition, paving and subsurface conditions, and skid resistance of existing surfaces.
- Replace county transit vehicles in accordance with useful standards established in the Maryland Transit Asset Management Plan.

Objective: Improve drainage along roadways that have recurring flooding or maybe susceptible to storm surges.

Strategies:

- As part of the road, bridge and culvert condition inventory and guided by the County's All-Hazards Mitigation Plan, conduct hydrologic and hydraulic studies of key roadways and bridges.
- Replace, remove, or enlarge bridge and culvert stream crossings that are unable to pass the 10-year frequency flood flow.
- Maintain an aggressive program of debris removal from stream channels in the vicinity of bridges and culverts; monitor erosion and other indications of roadway undermining.
- Retrofit and modernize drainage channels along the most at-risk roadways.
- Pursue FEMA funding and other federal funding opportunities for pre-disaster mitigation.
- Monitor the adequacy of evacuation routes and revise or update as necessary.

More than 30 road segments are frequently flooded during major rainfall.

Source: Calvert County Division of Emergency Management

Goal 2: Eliminate traffic and pedestrian deaths and serious injuries.

Transportation-related deaths and severe injuries are preventable and unacceptable. Rural communities like Calvert County are increasingly adopting a Vision Zero strategy to eliminate all traffic fatalities and severe injuries, while increasing safe, healthy, equitable mobility for all. Vision Zero is a systems-oriented approach to safety and is founded on the following principles:

- The Calvert County Transportation Plan will support the County's Strategic Highway Safety Plan – Maryland Vision Zero Plan.
- Transportation–related deaths and severe injuries are preventable and unacceptable.
- Human life takes priority over mobility and other objectives of the road system. The road system should be safe for all users, for all modes of transportation, in all communities, and for people of all ages and abilities.
- Human error is inevitable; the transportation system should be designed to anticipate error so the consequences are not severe injury or death. Advancements in vehicle design and technology, as well as roadway engineering advancements, personal electronic device innovations, etc., are necessary components for avoiding the impacts of human errors.
- People are inherently vulnerable, and speed is a fundamental predictor of crash survival. The transportation system should be designed for speeds that protect human life.
- Safe human behaviors, education, and enforcement are essential contributors to a safe system.
- Policies at all levels of government need to align, making safety the highest priority for roadways.

While state and federal policies focus on driver licensing requirements, vehicle crashworthiness, and curbing antisocial behaviors like texting and driving or driving while under the influence of alcohol or other substances, a local government's Vision Zero plan typically focuses on:

- Engineering improvements such as reducing speeds, warning of hazards, fixing blind spots and dangerous intersections and improving street lighting.
- Educational activities such as Safe Routes to Schools program and bicycle safety programs.
- Enforcement of traffic laws with an emphasis on combating speeding, aggressive and impaired driving and distracted driving.
- Integrated transportation-land use planning and development reviews that put pedestrian safety and multimodal access ahead of traffic speed and maximum vehicle access points.

Objective: Improve data collection and dissemination to target enforcement activities to the highest causes and locations of traffic crashes.

Strategies:

- Establish a systematic, data-driven process to improve traffic safety on county roads; strategies should include both physical improvements and behavioral approaches (enforcement, education, etc.)
- Conduct routine data sharing and safety planning efforts among County and State agencies including the Calvert County Sheriff's Office and the Departments of Public Works, Planning & Zoning; Fire, Rescue and Emergency Management Services; MDOT State Highway Administration; Maryland State Police and community resources such as Calvert Alliance Against Substance Abuse.
- Continue efforts to support Calvert County Sheriff's Office and Maryland State Police with strategies and enforcement of distracted driving.

Table 12 - Frequent crash locations on county-owned roads

Mason Road
Little Cove Point Road
Mt. Harmony Road
Parran Road
Pond Woods Road
Skinner Turn Road
Wilson Road
Prince Frederick Blvd @ W. Dares Beach Road

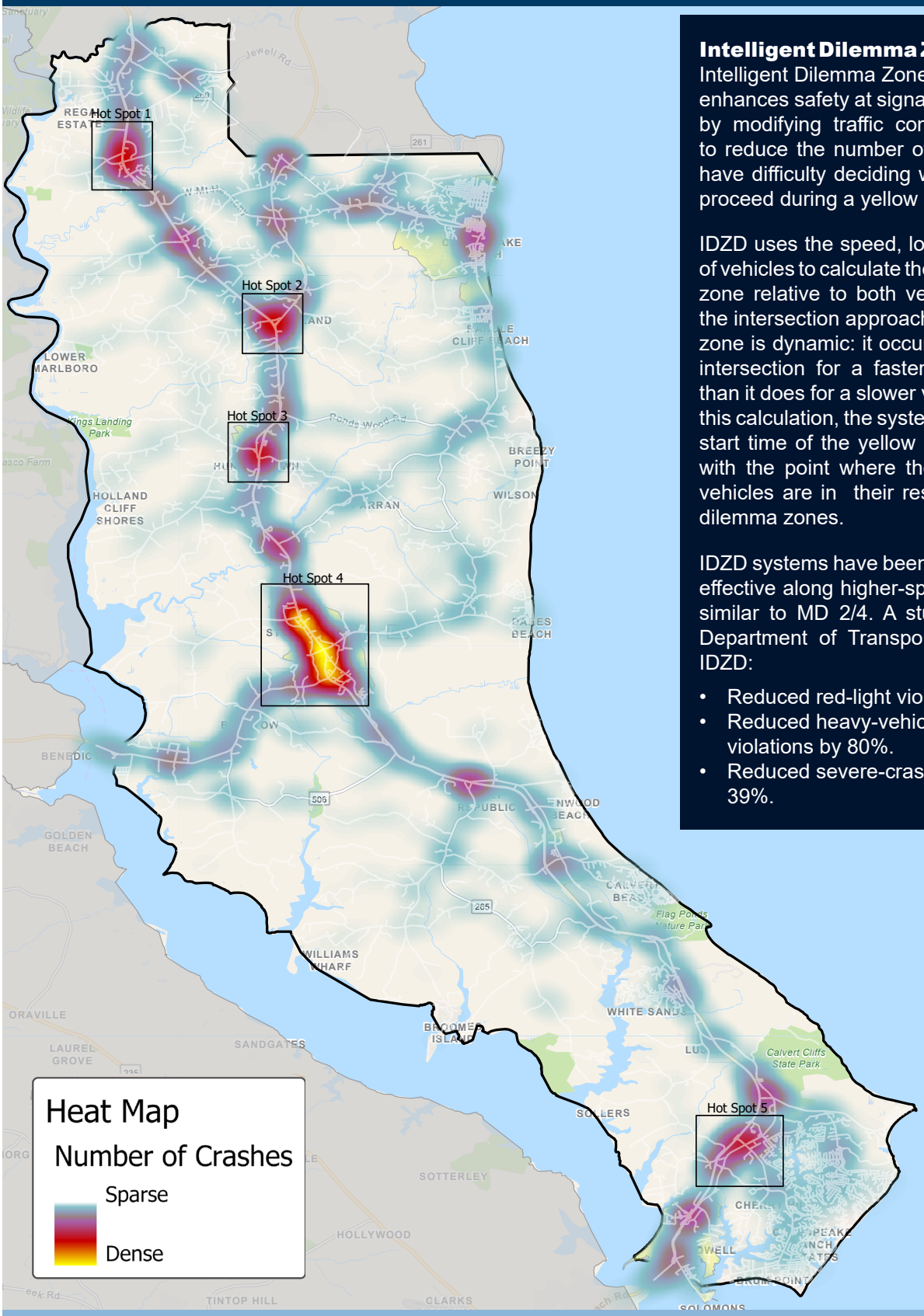
Source: Maryland Highway Safety Office, via Maryland iMap Open Data Portal

Objective: Maintain a continuous pipeline of traffic safety and pedestrian improvements.

Strategies:

- Request that MDOT SHA conduct or expand its pilot program on intelligent dilemma zone protection to one or more high speed intersections along MD 2/4.
- Include an annual request in the CTP Priority Letter to ensure that MDOT SHA includes Calvert County locations in its Crash Prevention Program.
- Analyze and design improvements on County-owned roads with the highest number of injury crashes.

Figure M - Frequent crash locations on state-owned roads (See pages A9-A14 of Appendix for Hot Spot details)



Intelligent Dilemma Zone Detection

Intelligent Dilemma Zone Detection (IDZD) enhances safety at signalized intersections by modifying traffic control signal timing to reduce the number of drivers that may have difficulty deciding whether to stop or proceed during a yellow phase.

IDZD uses the speed, location, and length of vehicles to calculate the location dilemma zone relative to both vehicle speeds and the intersection approach (i.e. the dilemma zone is dynamic: it occurs farther from the intersection for a faster traveling vehicle than it does for a slower vehicle.) Based on this calculation, the system then adjusts the start time of the yellow phase to coincide with the point where the fewest possible vehicles are in their respective projected dilemma zones.

IDZD systems have been found particularly effective along higher-speed rural arterials similar to MD 2/4. A study by the Texas Department of Transportation found that IDZD:

- Reduced red-light violations by 58%.
- Reduced heavy-vehicle red-light violations by 80%.
- Reduced severe-crash frequency by 39%.

Source: Maryland Highway Safety Office

Goal 3: Improve mobility within town centers.

The Town Center planning process will allow residents, businesses and County agencies to develop a specific plan of action to improve mobility therein; however, the right planning framework, policy tools, guided investments will be needed to do so.

Objective: Reduce the need for local traffic to use MD 2/4 within and approaching the Prince Frederick, Huntingtown and Dunkirk Town Centers.

Strategies:

Prince Frederick

1. Add a second exclusive turn lane eastbound on Stoakley Road to MD 2/4 northbound.
2. Make the final connection of Prince Frederick Boulevard to MD 2/4 and realign the northernmost entrance/exit from Calvert Health.
3. Extend Chesapeake Boulevard to meet Harrow Lane, then connect to Calvert Health.
4. Complete Fox Run Boulevard.
5. Examine and implement operational and safety improvements on MD 231 between the College of Southern Maryland Prince Frederick Campus and Sixes Road.

Huntingtown

Realign junction of MD 521/ MD 524 and MD 2/4 in Huntingtown to allow for continuous movements wherever possible

Dunkirk

Identify a loop road alignment or parallel connection to the west of Dunkirk District Park between Smithville Road or Ferry Landing Road/Town Center Boulevard or Yellow Bank Road.

Figure N1 - Prince Frederick Improvement Concept

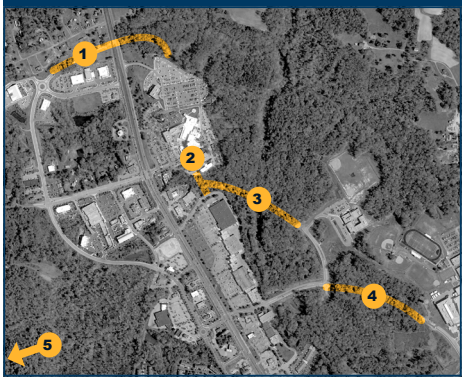


Figure N2 - Huntingtown Improvement Concept

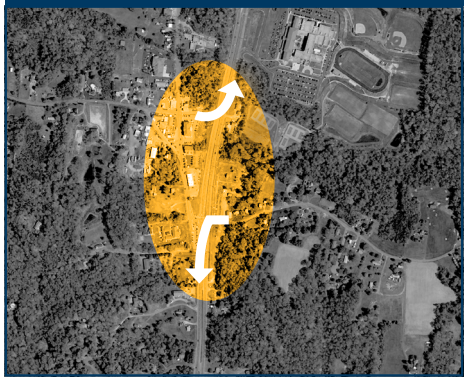


Figure N3 - Dunkirk Improvement Concept

Objective: Upgrade the bicycle and pedestrian network.

Strategies:

- Update the Calvert County Road Ordinance and subdivision regulations to require sidewalk connectivity from the subdivision to the nearest logical termini within Town Centers. If right-of-way acquisition is required from property owners other than the subdivision developer, accept in-lieu of sidewalk construction while the county acquires the right of way; or, complete a similar length section of sidewalk in another part of the Town Center.
- Fill key gaps in the pedestrian network along MD 2/4 by prioritizing MDOT SHA Sidewalk Retrofit Program requests.
- Examine opportunities to improve pedestrian access to schools using the Safe Routes to Schools program model.
- Advance multi-use paths which primarily serve a transportation purpose as described in the Calvert County Land Preservation, Parks and Recreation Plan (LPPRP.)

Objective: Strengthen policy and financial tools to guide targeted investments.

The Calvert County Zoning Ordinance (CCZO) provides for an adequate public facilities test (commonly known as an “APF”) to evaluate the extent to which existing roadways can accommodate new residential, commercial or industrial development. The Zoning Ordinance requires that a traffic impact study be conducted and establishes a level of service standard which varies by roadway type and development location. Developments subject to APF regulations may not be permitted unless the developer mitigates the additional traffic brought by the development; APF grants the Director and grants the Director of Public Works broad authority to determine mitigation measures to achieve adequacy.

In theory, APF should provide a mechanism to manage and maintain the transportation system for traffic added to the network by new development. In practice, this is much more difficult to achieve because the scale and timing of developments and transportation improvements rarely match. For example, a subdivision of 60 residential units in the Prince Frederick Town Center hardly generates enough excise tax revenue to even begin engineering the improvements envisioned by this transportation plan, much less build the improvements. Requiring a developer to mitigate the additional traffic volumes back to a pre-development level of service (turn lanes, traffic signals, non-motorized improvements, etc.) is economically infeasible for developments at the scale built in the Town Centers.

Strategy:

Department of Public Works and Department of Planning & Zoning should study the development process and legal issues of APF to determine if a “fee-in-lieu” approach should be implemented or excise tax increased for a dedicated purpose within Town Centers. As each Town Center master plan is prepared, the transportation element can be used to establish the extent and timing of improvements which are necessary, and the County should then set a fair per unit fee to be paid by building permit applicants. These fees can be used to leverage county and state funding for improvements.

Figure O1 - Prince Frederick Priority Sidewalk Improvements

Figure O2 - Dunkirk Priority Sidewalk Improvements

Goal 4: Expand practical choices and achieve reliable travel times for commuters using MD 2/4.

More so than the actual travel time and distance, drivers nationally cite the reliability of their commute as their most significant concern. Drivers are used to congestion and they expect and plan for some delay, particularly during peak driving times but they are less tolerant of unexpected delays because they cause the traveler to be late for work or important meetings, miss appointments, or incur extra childcare fees. Shippers that face unexpected delay may lose money and disrupt just-in-time delivery and manufacturing processes. When the daily grind of a long commute becomes too much, drivers also want practical and reliable alternatives to driving alone such as carpooling and commuter buses.

Objective: Gather and disseminate timely intelligence on traffic conditions along MD 2/4.

Strategies:

If you can't measure it, you can't improve it – and unfortunately, there is very little systemic monitoring and measurement of traffic congestion in Calvert County which makes it difficult to improve the situation. For individual drivers, mobile applications such as Waze and Google Maps help drivers to find the fastest route to their destination, but they are no substitute for active management of traffic along an entire corridor.

MDOT SHA should:

- Include MD 2/4 in the annual Maryland Mobility Report.
- Place traffic cameras, speed sensors and other real-time data collection tools along MD 2/4.
- Install variable message signs on MD 4 northbound in advance of MD 231 and the MD 2/4 split.

Dynamic message signs provide advance information on traffic conditions.

Objective: Deploy intelligent transportation technologies to improve travel time reliability on MD 2/4.

Maryland is executing a multi-phase traffic relief plan that involves a combination of geometric roadway capacity increases and installation of a 'Smart Signal System' on critical corridors throughout the state. These systems use real-time data to dynamically adapt signals to variable traffic demand. Using these systems, roadways that require additional vehicular capacity will receive more time when they needed it for throughput, effectively reducing delay experienced system wide. MDOT SHA should include MD 2/4 in the next round of Smart Signals corridors and Intelligent Dilemma Zone Detection locations.

Establishing an Intelligent Transportation Systems Backbone in Calvert County

Technology has been long-embraced at the state and local levels in Maryland, although certain corridors have been of greater focus than others. Numerous plans and programs have been established which embrace the approach that technology is one of the strongest tools to manage and mitigate growing traffic congestion. Beyond just roadways and traffic signals, a smart and technology-enabled transportation system requires a network of infrastructure including data collection equipment, communications equipment, data storage, monitoring systems, and dedicated maintenance staff. Together, these assets provide information that can aid in decision making and serve as tools to better manage traffic congestion when it occurs.

Calvert County's Comprehensive Plan calls for the continued development of a broadband network for use in a variety of applications. This network could be leveraged to achieve greater communications capabilities with transportation technology.

Objective: Jointly develop and implement an access management plan for MD 2/4 with MDOT SHA.

Access management plans are used as a guide for State and local agencies in providing a consistent means to address the requests for access from development/redevelopment properties along state highway corridors. The goal is to develop plans that will allow for economic growth and rational development while maintaining or improving mobility, safety and capacity of the existing roadway. The SHA and local governments are actively developing plans and access guidelines along selected highway corridors to prepare for development taking place today or many years in the future. The most common misconception of a draft access management plan is that it will be implemented immediately, and property owners will lose existing access to the highway. This is not the case. These Access Management Plans are flexible and will be implemented through the local development process. There will be circumstances that will lead to changes in the proposed approach in an area. Each property will be examined independently to determine its relationship to the plan/policy and what is needed to maintain a corridor.

MDOT SHA and Calvert County should work together to develop an access management plan and use the development review and approval process to use tools such as:

- Rejecting new private entrances along MD 2/4 or issue “temporary” private access permits, pending location of future alternate access.
- Consolidating existing private entrances so that adjacent properties share common driveways.
- Limiting the location and number of median openings.
- Restricting turning movements into and out of properties which limits the number of conflict points at driveway locations.
- Allowing access to corner parcels only from lower functioning roadways.

Objective: Expand commuter bus service to reflect the actual travel patterns of County residents.

Recent data from the U.S. Census indicates that travel to and from the core of Washington, DC is remaining steady, while travel from Calvert to northern Prince George’s County (College Park), Anne Arundel County (Annapolis/Parole), Montgomery County (I-270 corridor) and Northern Virginia (Alexandria/Pentagon) is rising.

As such, commuter bus service to and from Calvert County should be reviewed by MDOT MTA and consideration given to:

- New service from Prince Frederick to state office complexes in the downtown Annapolis government center.
- New service to federal facilities in northern Prince George’s County (New Carrollton, Greenbelt and College Park.)
- Restructuring certain routes to connect from Prince Frederick/Dunkirk to Alexandria, Virginia and the Pentagon.

As an interim step, MDOT MTA should consider establishing and subsidizing subscription-based van pool service to the above-named destinations.

MDOT MTA Commuter Bus service to Washington, DC is a practical commuting alternative for many.

Calvert County park-and-ride locations are often filled to capacity.

Goal 5: Meet unmet transportation needs for Calvert County's carless and limited-mobility households.

Calvert County lacks the density to support a robust network of local transit routes resulting in service that is very infrequent and with days and hours of service that do not meet the full needs of county residents in need of transportation assistance. This problem is not unique to rural communities and has a significant impact upon seniors and individuals with disabilities who need access to doctors' appointments, fresh foods, and social services. Seniors who can no longer drive but wish to remain an active part of the community through volunteering, pursuing a hobby, or attending civic events are also affected by the limited transit availability; some human services providers have vans bought through a federal grant program administered by MDOT MTA, but eligibility is limited to clients of the service. A volunteer-driven program to assist seniors with door-to-door transportation led by Partners in Care withdrew from Calvert County in 2017 reducing the options, especially for discretionary trips.

Low-income households also struggle to access similar services and opportunities and face the challenge of not being eligible for many of the programs otherwise available to seniors and individuals with disabilities. When such households do have a car, the reliability of the vehicle is often in question making it more difficult to show up for work on time.

Objective: Establish small-scale programs to provide transportation services to the elderly, disabled and low-income individuals seeking work.

Strategies:

The Tri-County Council of Southern Maryland should:

- Re-establish or develop a network of volunteer drivers to meet the discretionary and/or off-peak trips for seniors and individuals with disabilities.
- Recruit a non-profit organization to Southern Maryland to provide a Wheels to Work-like program which restores vehicles and makes them available at low cost to eligible residents.
- Encourage the College of Southern Maryland and other career technology education programs to link their training programs to assist low-income persons in routine auto maintenance and repairs.

Objective: Improve connections between areas with concentrations of low-income, auto-less households & commercial employment centers.

Strategies:

- Establish on-demand or subscription-based evening bus service hours to reflect hours of operation of major retail centers in Prince Frederick and Dunkirk[6].
- Establish a minimum service standard of 60 minutes for fixed route services to and from Prince Frederick.
- Examine periodic fare increases consistent with MDOT MTA policies and/or increasing county funds to support local transit service.
- Defer investment in a new transit center until such time as service levels warrant it.

The Howard County all-volunteer NeighborRide program is a model program for senior citizen mobility.

Calvert County Public Transportation provides a valuable service for local trips.

[6] Subscription-based service" refers is a method of establishing ridership by allowing a user to pay fee for a certain number trips per month as needed rather for than a full monthly transit pass. A subscription allows the transit agency to operate service where demand may be too low for a traditional fixed-route, fixed-schedule bus route.

Conclusion and Path Forward

Calvert County's Comprehensive Plan establishes two planning imperatives: preserve the rural landscape and create vibrant Town Centers. These values work together and mutually sustain each other. The resulting land use and development must be supported by a transportation system that reinforces these values. This comprehensive countywide transportation system tries to achieve a balance that supports the measured growth approach in the comprehensive plan. The challenge that must be addressed in doing so is this: providing too much road capacity for free-flowing traffic which will encourage more development by retaining a travel time to employment centers that is acceptable to commuters; providing too little road capacity (especially within and approaching the Town Centers) frustrate the desire of residents to move freely and safely within the county.

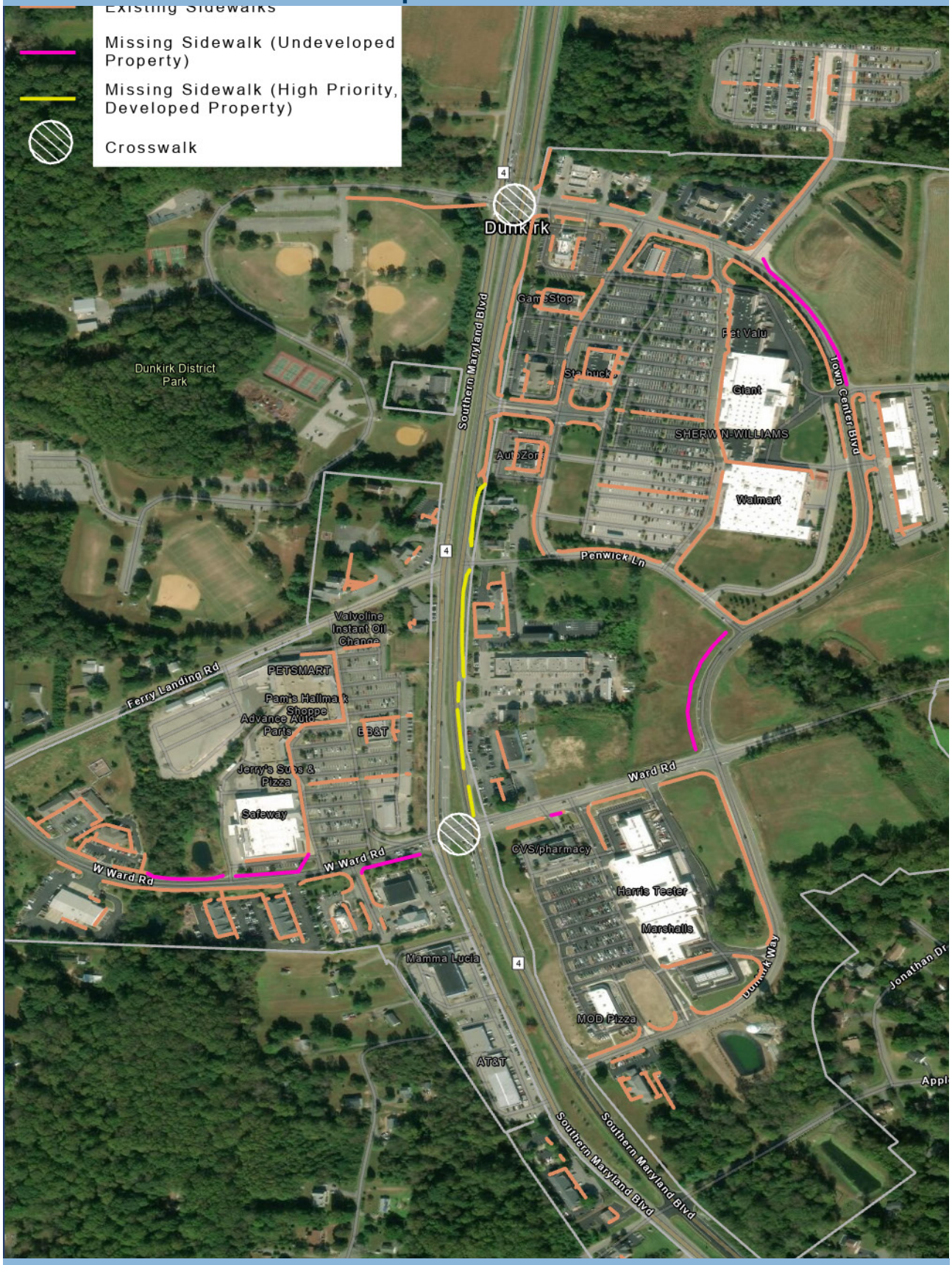
Road capacity is but one issue. The county has responsibility to maintain existing roads, bridges and culverts in a state of good repair and resilient to the pressures of climate change, to provide services for carless and limited mobility populations, and to advocate for improvements to state roads and transit services to better keep Calvert County moving.

The primary constraint on achieving the transportation goals and objectives of this plan is funding. MDOT is making considerable investments in mega-projects in the metropolitan areas where traffic congestion is far worse than in Calvert County and other rural areas. Calvert County spends relatively little on providing new transportation capacity and focuses its resources on maintaining the existing transportation system. If new transportation capacity is to be built, it will require a partnership between the county and state with participation from developers adding new trips to the transportation system. Reorienting the county's adequate public facilities regulations to accumulate fees from developers rather than very small improvements may be the best approach to gain developer participation.

Building new roads is a lengthy process, and expensive in dollars and environmental effects. As such, the most promising strategy for the county is not to focus on building new lanes on existing roadways, but rather to focus on operational, safety and technological improvements which have high value at relatively low cost. Most of the roadway improvements should be further developed as part of the Town Center planning process – both to establish an appropriate design for the improvement as well as to set thresholds for when the improvement should be built.

Appendix

Dunkirk Sidewalk Network Map



Source: Data collected by SAI, April 2019

Huntingtown Sidewalk Network Map

Source: Data collected by SAI, April 2019

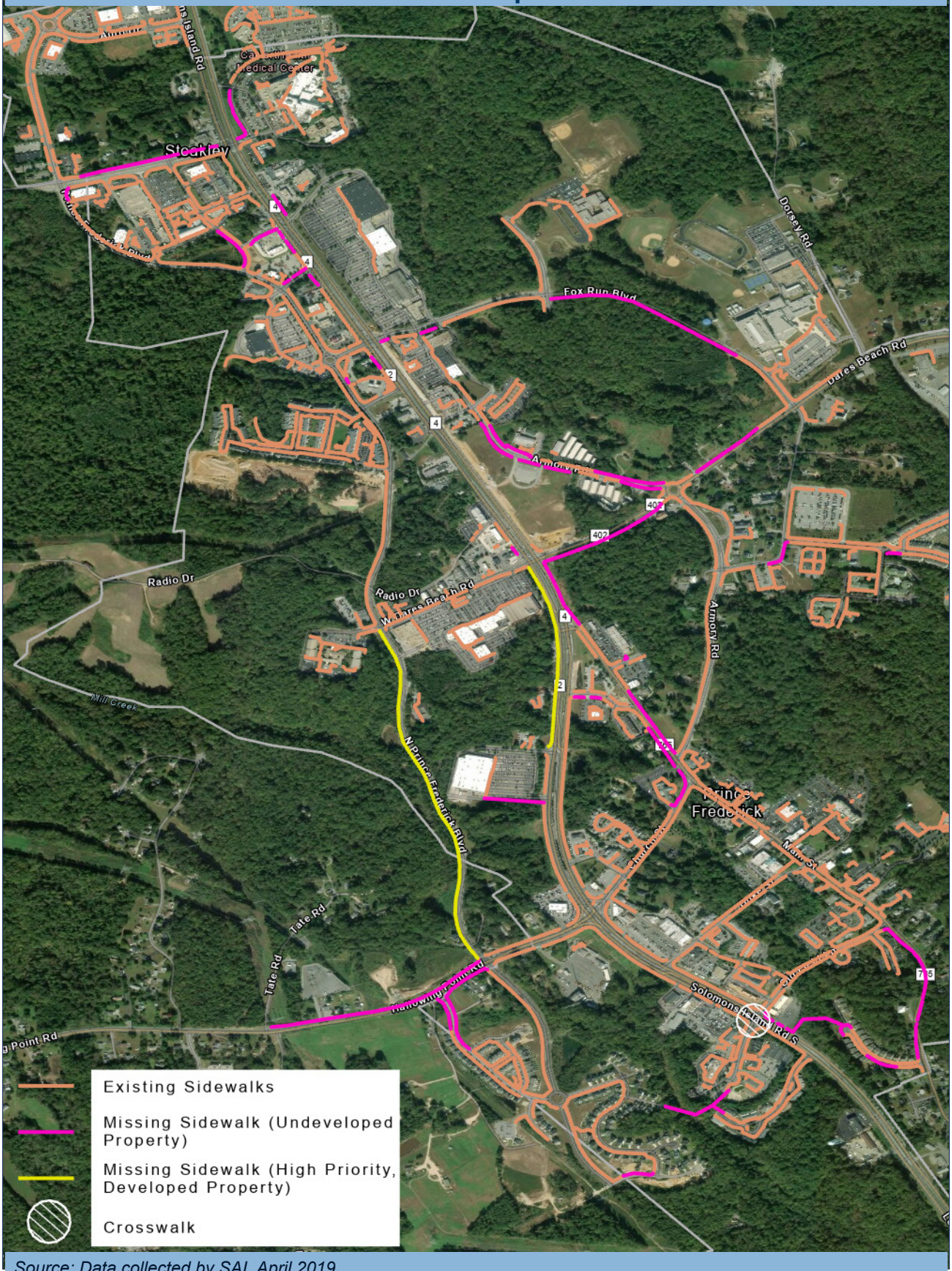
Lusby Sidewalk Network Map

Source: Data collected by SAI, April 2019

Owings Sidewalk Network Map

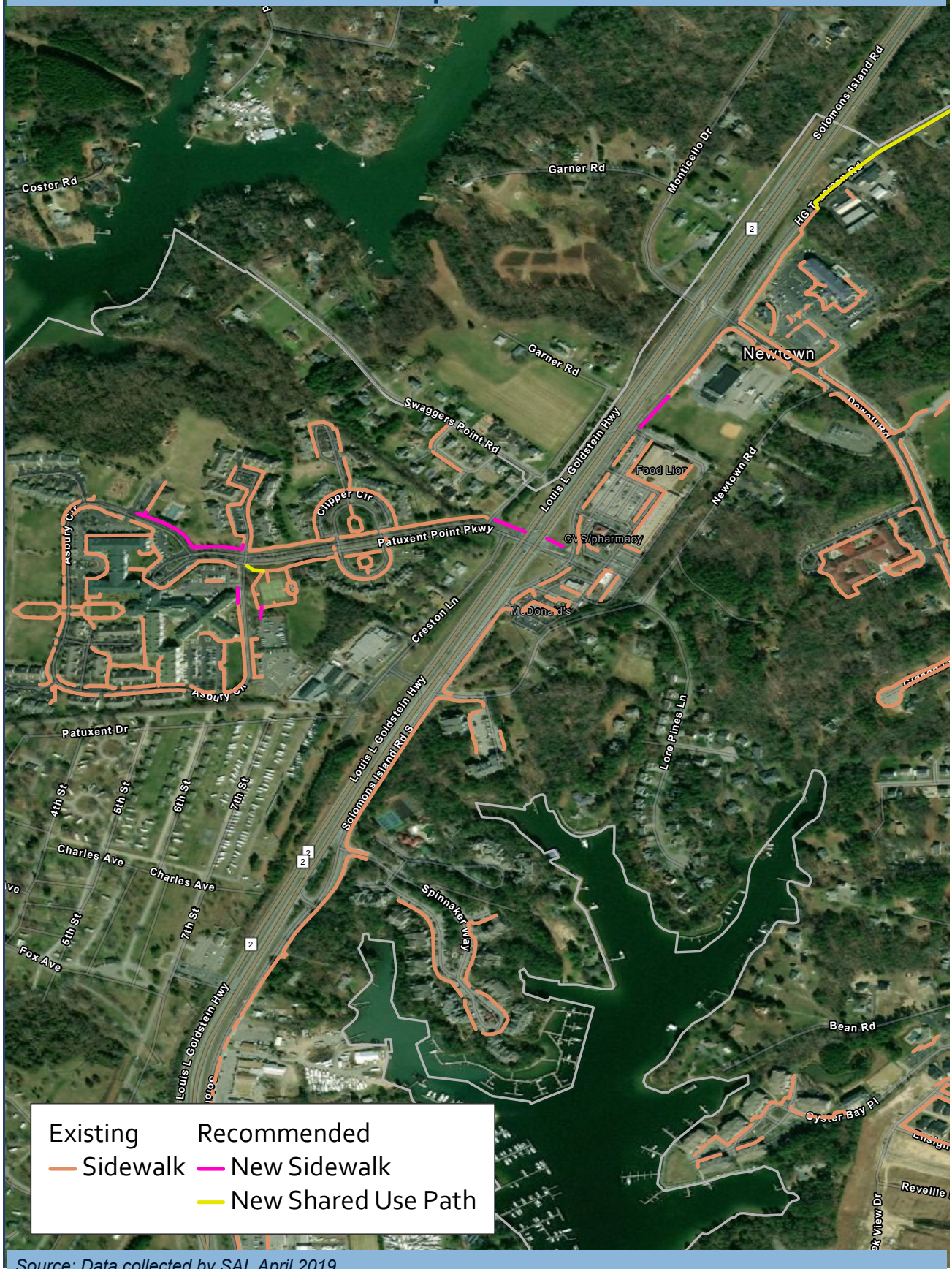
Source: Data collected by SAI, April 2019

Prince Frederick Sidewalk Network Map



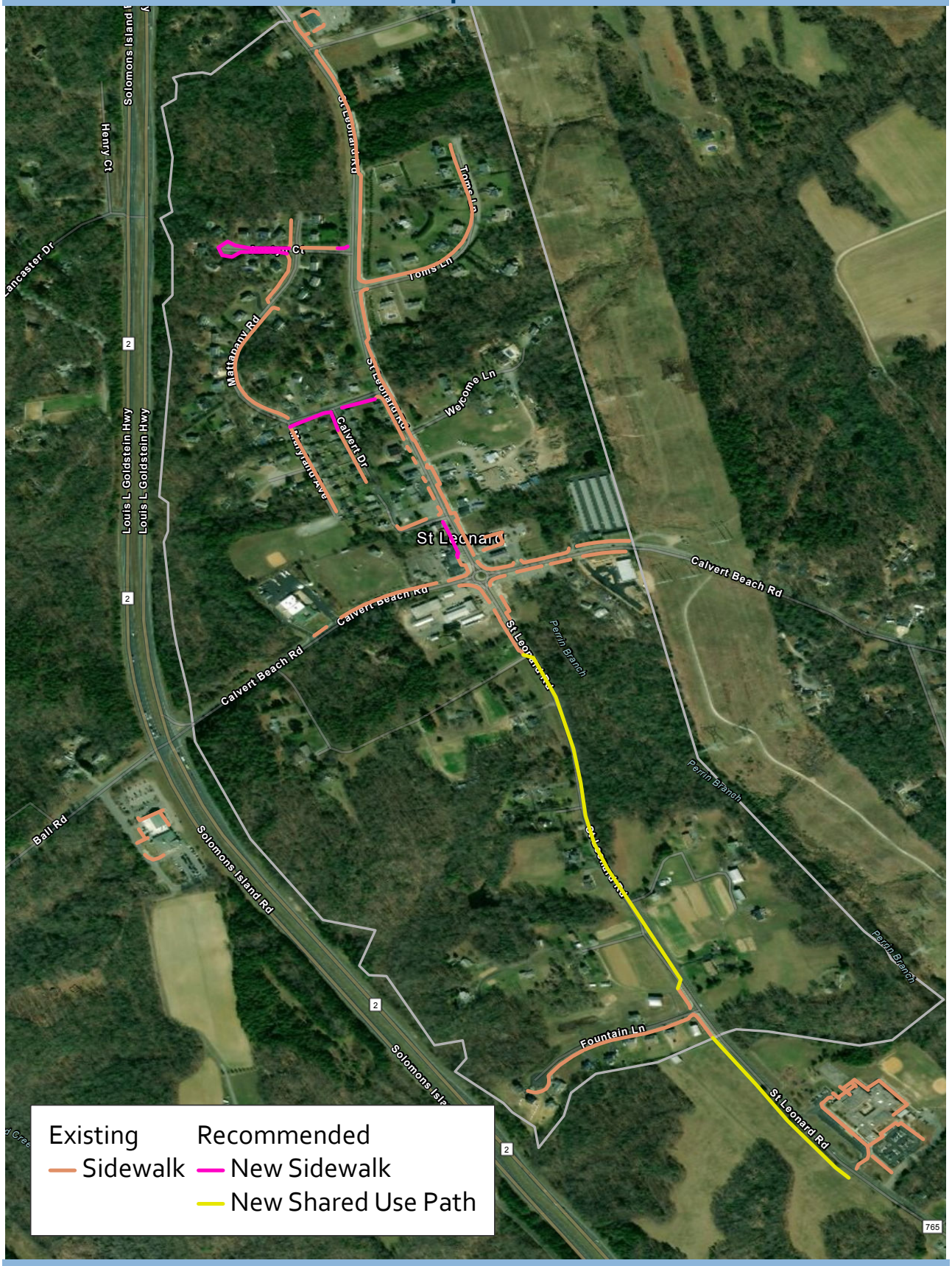
Source: Data collected by SAI, April 2019

Solomons Sidewalk Network Map



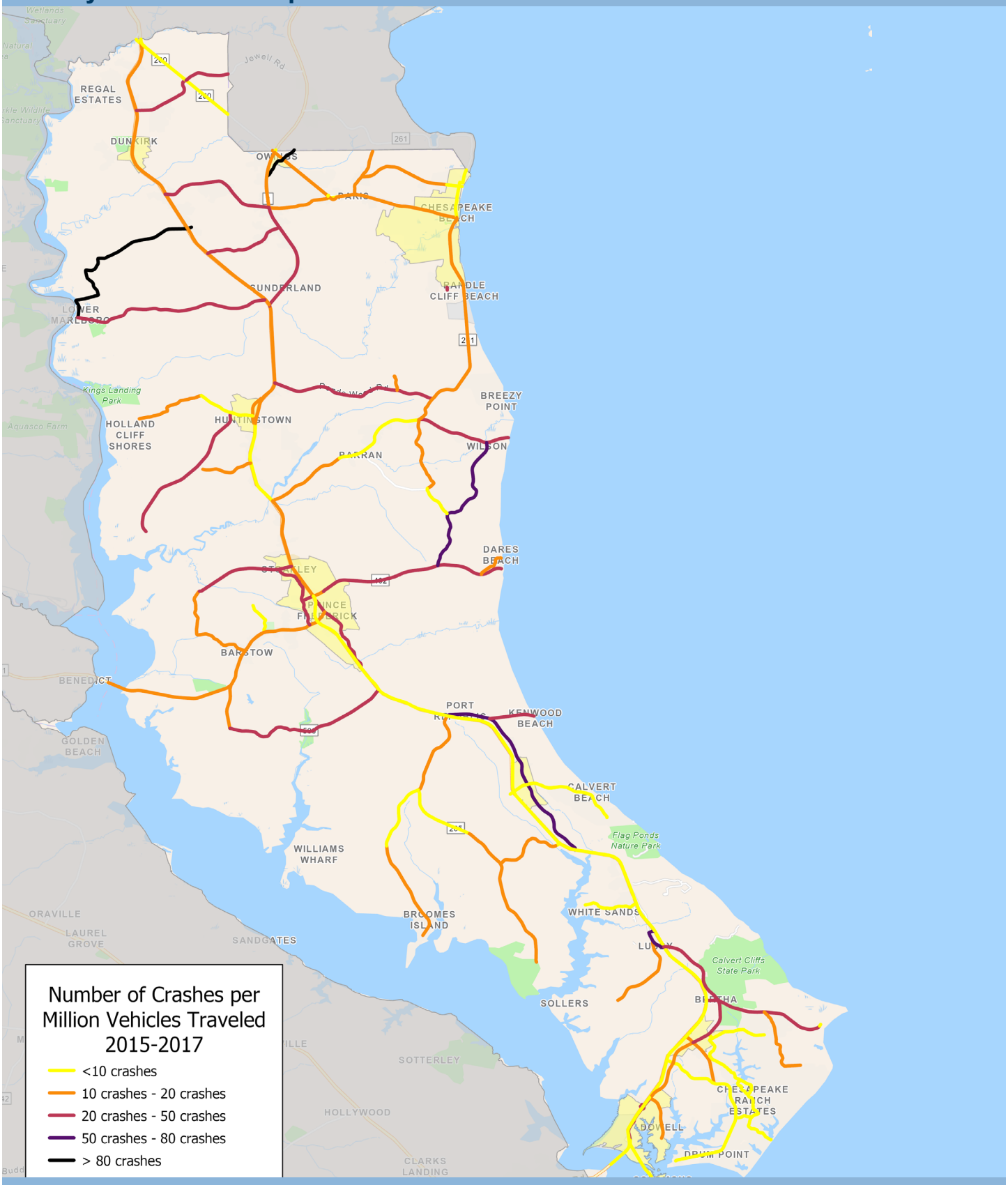
Source: Data collected by SAI, April 2019

St. Leonard Sidewalk Network Map



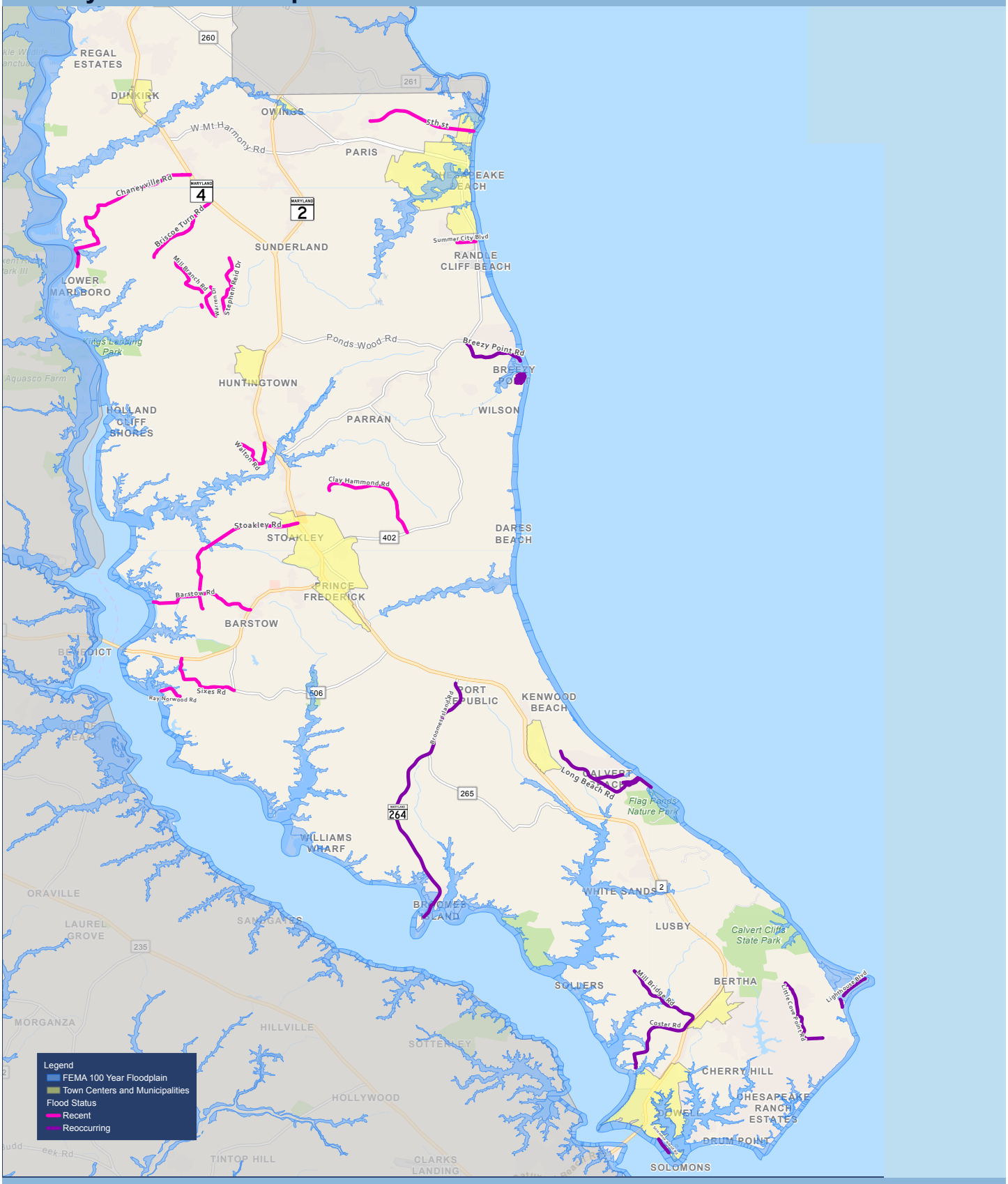
Source: Data collected by SAI, April 2019

County Crash Rate Map



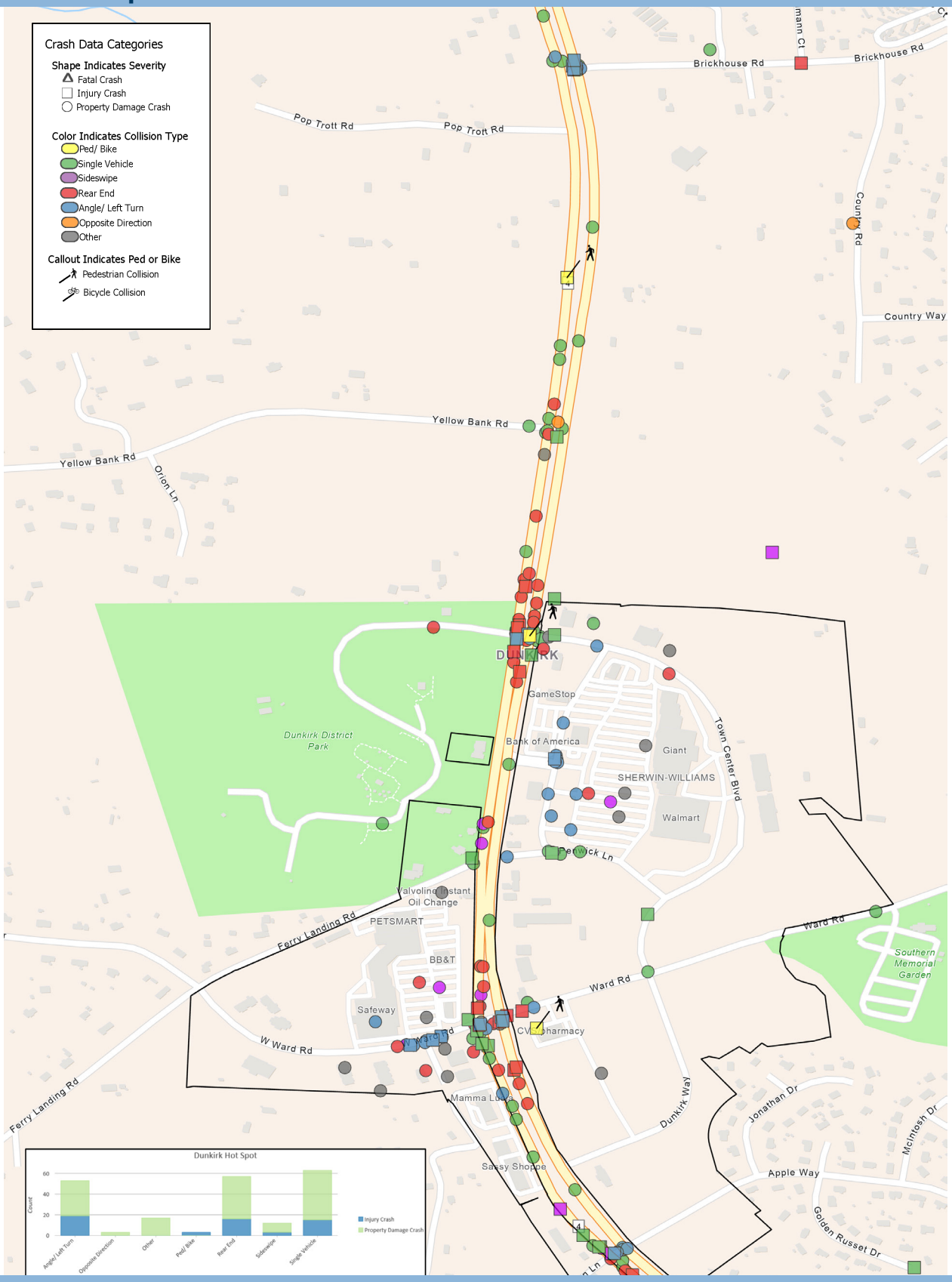
Source: Maryland Highway Safety Office, via Maryland iMap Open Data Portal

County Flood Plain Map



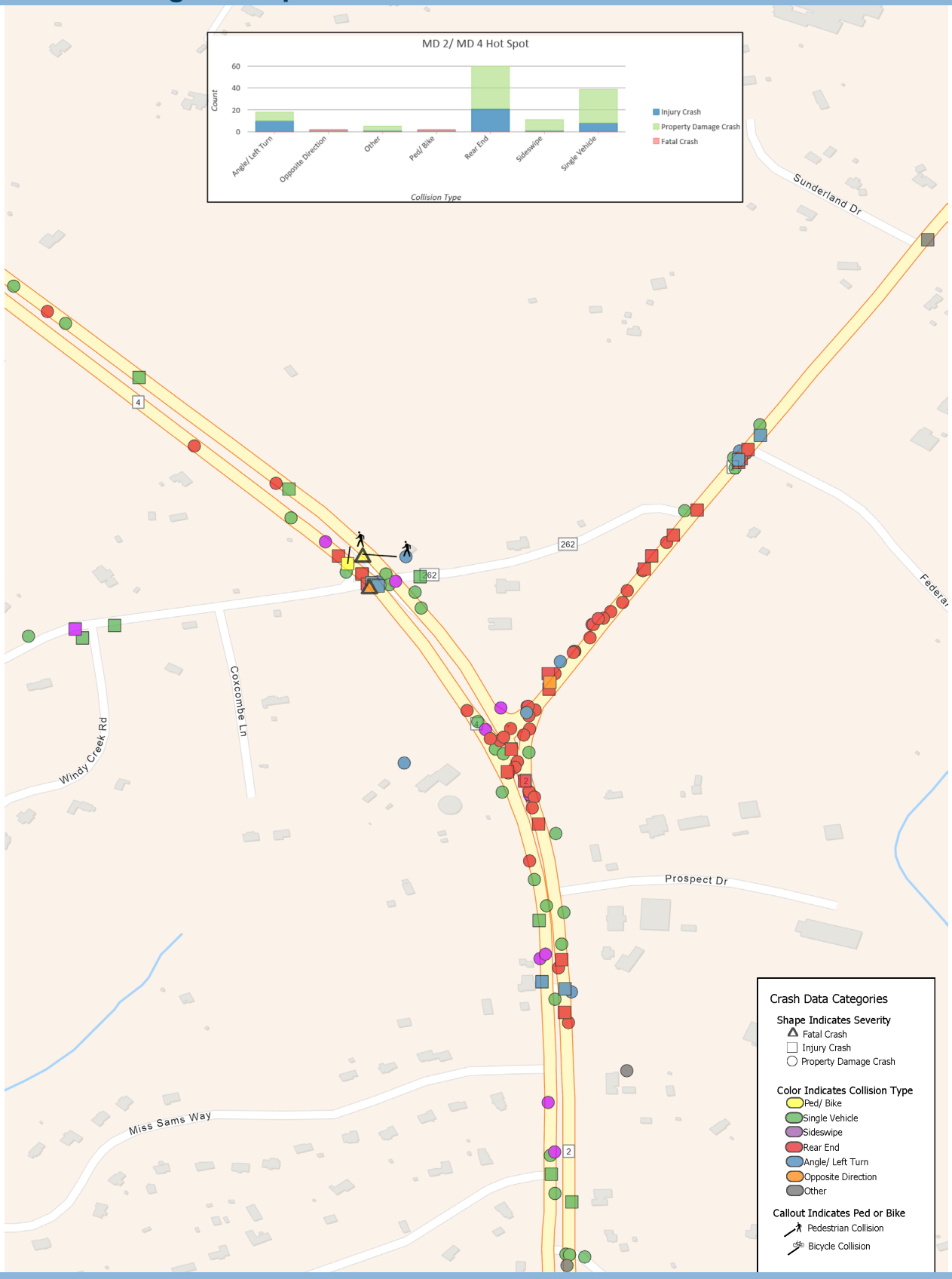
Source: Maryland Highway Safety Office, via Maryland iMap Open Data Portal

Dunkirk Hot Spot



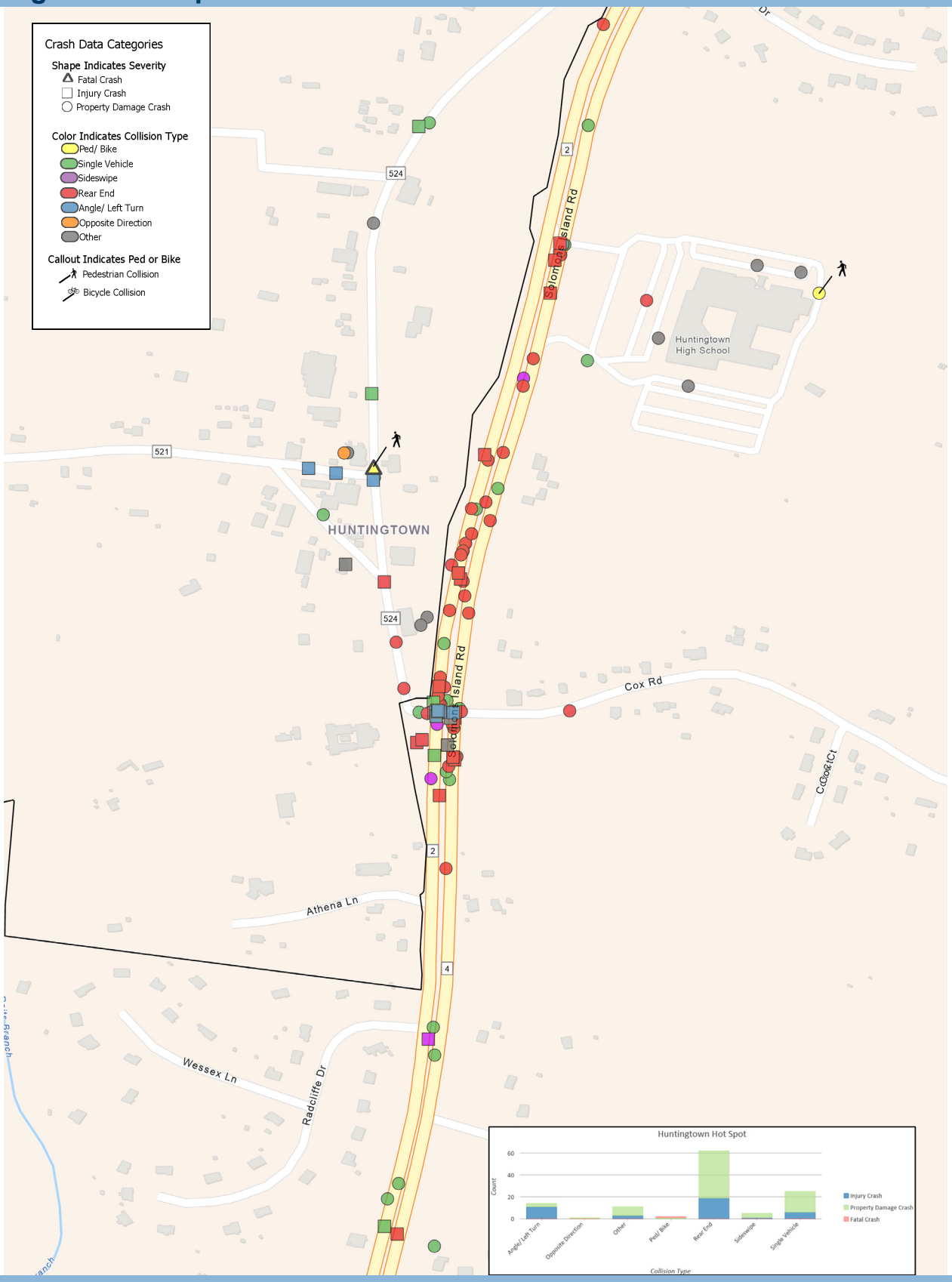
Source: Maryland Highway Safety Office, via Maryland iMap Open Data Portal

MD 2/4 Interchange Hot Spot



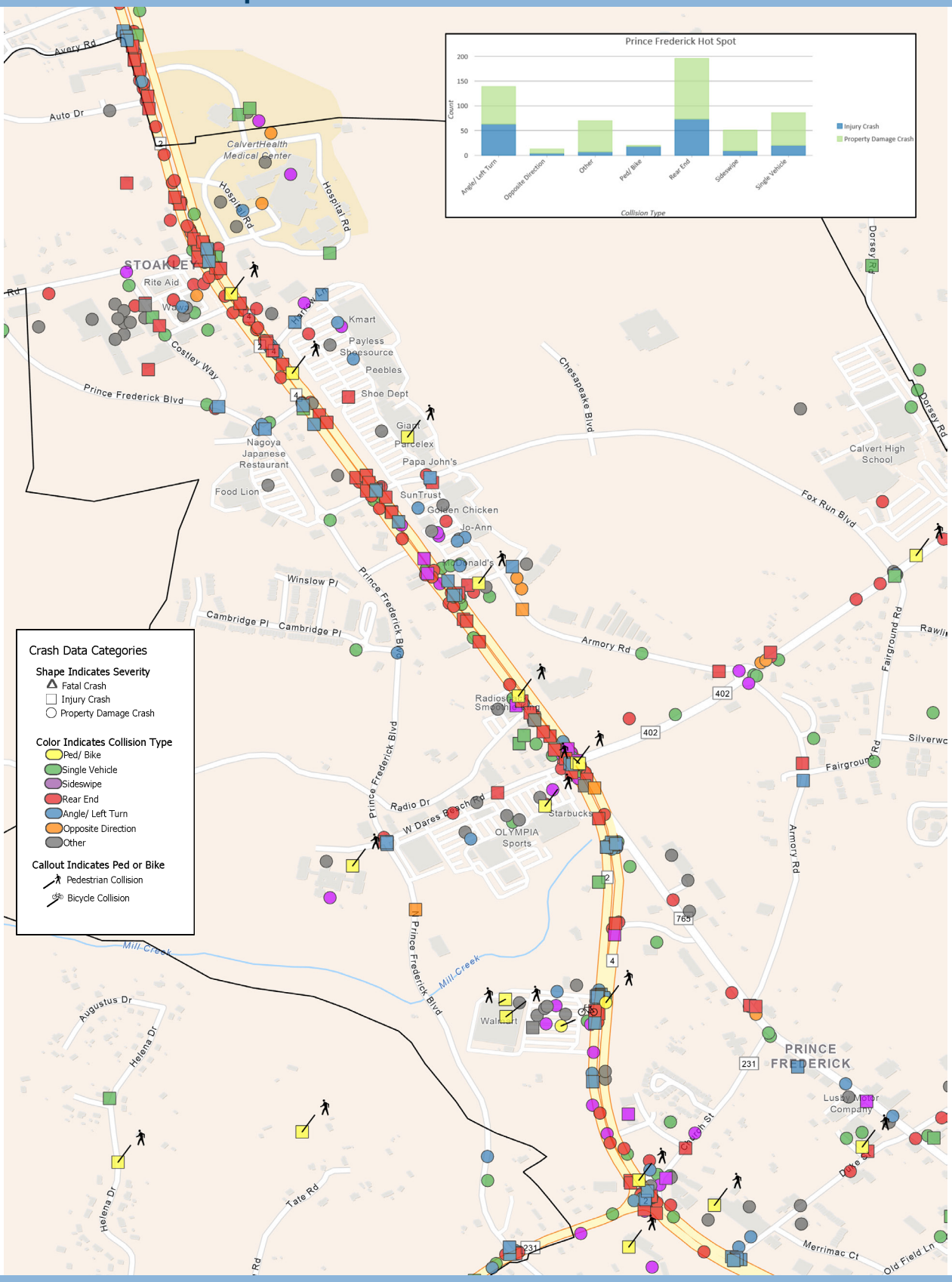
Source: Maryland Highway Safety Office, via Maryland iMap Open Data Portal

Huntingtown Hot Spot



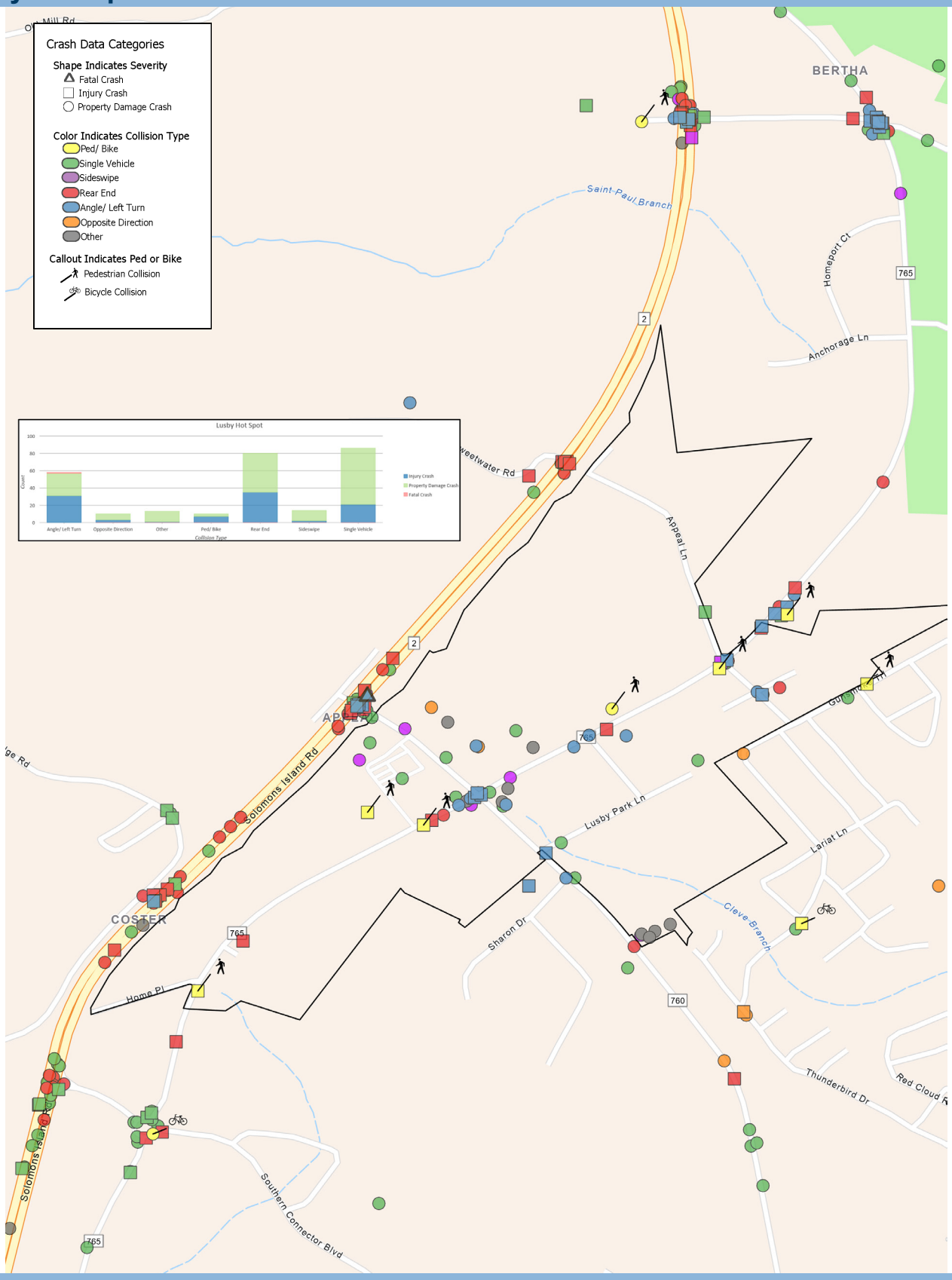
Source: Maryland Highway Safety Office, via Maryland iMap Open Data Portal

Prince Frederick Hot Spot



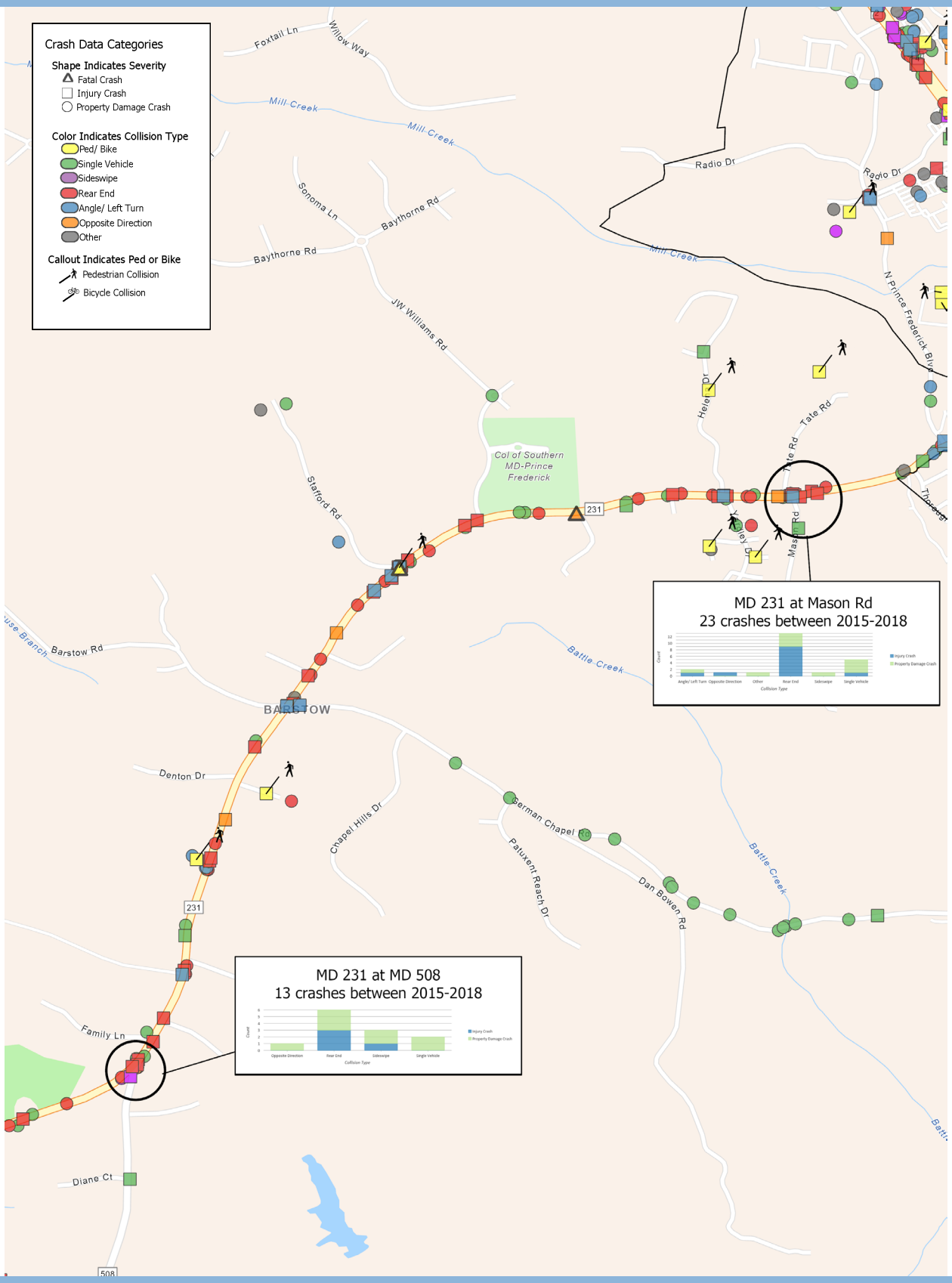
Source: Maryland Highway Safety Office, via Maryland iMap Open Data Portal

Lusby Hot Spot



Source: Maryland Highway Safety Office, via Maryland iMap Open Data Portal

SHA Crash Prevention Zones



Source: Maryland Highway Safety Office, via Maryland iMap Open Data Portal

CALVERT COUNTY TRANSPORTATION PLAN

TECHNICAL MEMORANDUM #1
Review of Plans and Studies

March 2019

SABRA & ASSOCIATES
Engineering Innovative Solutions

Note: This is the first in a series of technical memoranda prepared for the Calvert County Department of Planning & Zoning in developing the Calvert County Transportation Plan. The purpose of each technical memorandum prepared for is to present facts, analysis, ideas, issues and recommendations that will inform the plan. The views expressed, and recommendations offered in each memorandum are solely based on the consultant's judgment and should not be considered as endorsed by the Calvert County Department of Planning & Zoning or any other county department or officer.

Contents

Introduction

As part of developing Calvert 2040, the Calvert County Comprehensive Plan, the Department of Planning & Zoning has initiated an update of the County's Transportation Plan which was initially written in 1997. The purpose of thetransportation plan is to guide the County's future investments in and advocacy for the County's multimodaltransportation network.

The purpose of this Technical Memorandum is to provide a comprehensive listing of transportation plans and projects identified by local, regional and state agencies for potential implementation in Calvert County. This inventory makes no judgment as to the efficacy of any project; it is assumed that if a project is included in a plan, then it has some level of endorsement by the sponsoring agency unless otherwise specifically noted. This memorandum also summarizes relevant statutes which govern the traffic and transportation planning, engineering and construction processes.

An accompanying geodatabase has been created for ease of reference and analysis in preparing the transportation plan. The geodatabase lists each specific project and includes a brief description, project source and sponsoring agency, modal type, status, and cost estimate, if available.

Transportation Plan Background and Context

Over a thirty-year period beginning in the early 1980s, Calvert County's population grew by nearly 170% from 34,638 residents in 1980 to 91,502 residents in 2017[1]. This growth can be attributed to the always strong federal sector in the core of Washington, DC and at Joint Base Andrews, Suitland and New Carrollton among other suburbs, and base realignment to the benefit of Patuxent River Naval Air Station. Newcomers were willing to exchange a longer commute for Calvert County's high quality of life with easy access to the Chesapeake Bay and Patuxent River, low taxes and good schools.

During that time, the Maryland Department of Transportation State Highway Administration (MDOT SHA) widened portions of MD 2/4 and worked closely with the County on access management strategies to mitigate some of the stop-and-go traffic; MDOT's Maryland Transit Administration grew its commuter bus ridership and park-and-ride capacity nearly ten-fold. The county also implemented growth management strategies that preserved rural areas and targeted town centers in Solomons, Lusby, Prince Frederick, Dunkirk and elsewhere for residential and commercial development.

Key Transportation Characteristics[2]	2009	2016
Workers 16 Years or Older	45431	44872
Drive Alone	90.2%	90.1%
Use Public Transit	3%	3%
No Vehicle in Household	1.0%	1.5%
Work in County of residence	41.1%	38.1%
Average time to work (minutes)	39.3	41.4
Greater than 60 min drive	26.4%	29.0%

Thirty years after the residential boom started, population growth has stabilized. Projections through 2040 indicate a rate of growth in

[1] https://www.census.gov/programs-surveys/popest/data/tables.2017.html retrieved on March 1, 2019
[2] https://www.census.gov/quickfacts/fact/table/calvertcountymaryland,US/PST045218 retrieved on March 1, 2019

Calvert County averaging 0.5% annually.[3] While Calvert County's population growth has stabilized, its demographics and commuting patterns are changing rapidly. Baby boom retirements have reduced the number of persons in the workforce, but those who are working are do so with a longer commute to a destination outside of the county.

While managing congestion and improving travel reliability are the County's primary goals outlined in the draft comprehensive plan, integrating local and state efforts to improve traffic safety, identifying the most critical gaps in the pedestrian and bicycle network, maintaining roads in a state of good repair, and improving the resiliency of the County's transportation infrastructure all play an important role supporting in maintaining the high quality of life to which residents have become accustomed. The Calvert County Transportation Plan will address these issues to chart the next 20 years of integrated transportation and land use planning in Calvert County.

Relevant Local Transportation Planning & Policy Statutes

The Calvert County Zoning Ordinance (Articles 5.3.13, 6-10.01 and 7-1.05, et al.) provides for an adequate public facilities (APF) test (commonly known as an "APFO") to evaluate the extent to which existing roadways can accommodate new residential, commercial or industrial development. The zoning ordinance establishes a broad process by which traffic studies are to be conducted and establishes a level of service standard which varies by roadway type and development location. Developments may not be permitted unless the developer mitigates the additional traffic brought by the development; the Director of Public Works has broad authority to determine mitigation measures to achieve adequacy.

Separate from the county's APF regulations is the County's **building excise tax (Chapter 136-11, Article III)** which is applied as either "per dwelling unit" or per square foot of commercial/industrial development. All revenue generated by commercial, industrial, or institutional construction and $350 of each residential assessment is credited to the Solid Waste Enterprise Fund; each residential unit is assessed an excise tax between $5,100 and $12,150 depending on the type of unit; $3,500 of the excise tax is dedicated to the County's road account and budgeted through the usual appropriations process.

Chapter 104-2 of the County Code is commonly referred to as the Road Ordinance and was last updated in 2018. It establishes regulations and criteria for the planning, construction, improvement, reconstruction, maintenance, and repair of roads, including but not limited to sidewalks, curbs and gutters, storm drainage facilities, utilities, incidental structures, streetlighting, and landscaping, etc.

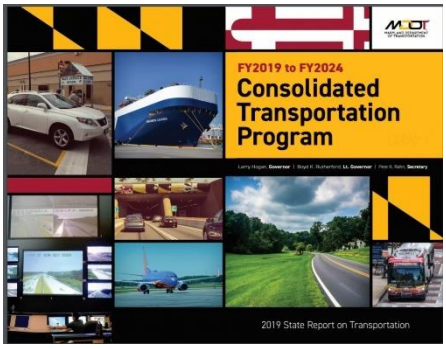
[3] Moving Forward 2040: C-SMMPO Long Range Transportation Plan, Chapter 2.1

Summary of Transportation Planning & Budget Documents

The County's transportation plans are established in several ways: communicating priorities to state officials, mode specific plans, and comprehensive planning documents required by state or federal law. This section summarizes the key transportation planning and budget documents since 2010. The plans and studies below identify more than 240 transportation projects ranging from new grade-separated interchanges along MD 2/4 to new sidewalks in the Town Centers. This inventory makes no judgment as to the efficacy of any project; it is assumed that if a project is included in a plan then it has some level of endorsement by the sponsoring agency.

Appendix 1 includes a full listing of the recommended projects accompanied by Appendix 2 which is a map of improvements for the county and each Town Center. A geodatabase has been created for ease of reference and analysis in preparing the Transportation Plan. The geodatabase lists of each specific project and includes a brief description, project source and sponsoring agency, modal type, status, and cost estimate.

Calvert County 2017 MDOT Priority Letter



In its 2017 letter to Maryland Transportation Secretary Pete Rahn regarding priorities for the MDOT Consolidated Transportation Program, the Calvert County Board of Commissioners primarily emphasized the continued importance of expanding capacity on MD 2/4, including widening of MD 2/4 from just south of Prince Frederick to the Anne Arundel County line and reconstruction of the Thomas Johnson Bridge connecting to St. Mary's County. The Board requested funding for the engineering and design of Phases 3A and 3B, which are just north of the phase which is currently under construction. The Board of County Commissioners also requested funding for the engineering and design of stormwater management strategies for an 860-foot segment of MD 261 in North Beach, which experiences serious flooding during coastal storms and heavy thunderstorms. An additional request was made regarding safety improvements on MD 4, from Fishers Station Road to the intersection of MD 4, MD 258, and Talbot Road. While this section of MD 4 is in Anne Arundel County, it impacts Calvert County because the northbound stretch of state highway does not have shoulders and can back up for miles in the event of a crash. The State Highway Administration has already studied the road segment and has moved to the design phase of the planned safety improvements. Other funding requests include several intersection safety and operations studies, transit service expansion, and streetscaping for Lusby Town Center.

Calvert County 2018 Priority Letter

As in the 2017 Priority Letter, the 2018 Calvert County Priority Letter is steadfast in its request for continued State support for the MD 2/4 widening project, the Governor Thomas Johnson Bridge reconstruction and MD 4 improvements project, intersection improvements along MD 231, safety enhancements along MD 4, transit service expansion, stormwater management interventions along MD 261 in North Beach, and several other safety and operations improvements. Since the 2017 Priority Letter, progress has been made on each of these projects, and Calvert County received additional funding for a Charlotte Hall transit route connection, benefitting the county's veteran population. New requests include a Safe Routes to School plan, providing sidewalks on MD 261 near Beach Elementary School, and safety improvements at Richfield Station Intersection.

Tri-County Council for Southern Maryland Priority Letter 2018

The Tri-County Council for Southern Maryland consists of Charles, Calvert, and St. Mary's Counties. To inform priorities for the FY 2019 – 2024 Maryland Department of Transportation Consolidated Plan, each county selects projects from their individual priority letters, which are then agreed upon by the Tri-County Council for Southern Maryland's Regional Infrastructure Advisory Committee. The highest priority project was in Calvert County and St. Mary's Counties, the Governor Thomas Johnson Bridge replacement with accompanying improvements to MD 2/4. Additional Calvert County projects include the enhancement of commuter bus services and the widening of MD 2/4 between MD 765A and Auto Drive.

Calvert County Comprehensive Plan (Dec. 2018 Draft)

The December 2018 draft of the Calvert County Comprehensive Plan provides the framework that will guide Calvert County development over the next 20 years. The plan establishes the County's mission, which is "to maintain and/or improve the quality of life for all citizens by promoting sustainable development, encouraging a stable and enduring economic base, providing for safety, healthy, and education, and preserving the natural, cultural, and historic assets of Calvert County." The Plan envisions a transportation system of safe highways with moderate congestion and readily available transit. Additionally, walking and biking would be practical modes of transportation within and around Town Centers. Key issues identified are as follows: peak hour traffic congestion at key intersections along MD 4 and MD 2/4, maintaining the character of rural collector roads, the lack of transit service within and between Town Centers, the limited connectivity of sidewalks and trails for bicyclist or pedestrian use, and the lengthy trips vehicles often take due to the county's incomplete road network.

The draft Comprehensive Plan calls for these issues to be addressed by:

- Building new roads that allow efficient and multi-modal circulation between subdivisions and within Town Centers
- A transportation system management program, including smart traffic signals, transit system priority, traffic engineering, transit, and carpooling/vanpooling
- The newly adopted Neighborhood Traffic Management program, where unincorporated communities may request safety studies from the County
- Coordinating and managing roadway access to MD 4 and MD 2/4 with Town Center circulation plans
- Studying the operations of arterials such as MD 231 and MD 260
- Working with the Maryland Transit Administration to increase bus service to Washington, DC and create local transit service areas
- Community land use planning

An additional consideration is the potential placement of a new Chesapeake Bay crossing in Calvert County. If the Maryland Department of Transportation decides Calvert County is the optimal location for an additional bridge, pass-through traffic to MD 4 will increase substantially and the County will need to contend with its impacts.

Calvert-St. Mary's MPO Long Range Transportation Plan: Moving Forward 2040

In 2016, the Calvert-St. Mary's Metropolitan Planning Organization (MPO) adopted a fiscally constrained 20-year transportation plan as required by federal law. The plan identifies future regional transportation investments, which can be made using reasonably available revenue as forecast by MDOT. The highest priority project identified was the four-lane widening of MD 4 from Patuxent Point Parkway in Calvert County to MD 235 in St. Mary's County, including a replacement for the Thomas Johnson Bridge. Additional projects listed for Calvert County are the construction of three interchanges along Solomons Island Road at the future Southern Connector Boulevard, MD 497, and Dowell Road.

State Highway Administration Highway Needs Inventory

The MDOT State Highway Administration Highway Needs Inventory (HNI) is a long term, financially unconstrained technical reference and planning document which identifies highway improvements to serve existing and projected population and economic activity in the state. The projects identified in this document represent only an acknowledgment of need based on technical analysis and adopted local and regional transportation plans. The HNI is not a construction program, and inclusion of a project does not represent a commitment to implementation. The HNI is not financially constrained nor is it based on revenue forecasts, statewide population, and land use patterns. Last revised in 2017, the HNI includes 15 Calvert County projects.

Projects on the SHA primary roadway system include:

- construction of three interchanges along Solomons Island Road (Southern Connector Boulevard, MD 497, and Ball/Calvert Beach Roads)
- reconstruction of four segments of divided highways with access control improvements along MD 2 and MD 4
- reconstruction of Thomas Johnson Bridge

Project on the secondary highway system include:

- Multi-lane reconstruction along several segments of MD 231, MD 260, and MD 261
- A divided highway reconstruction of MD 231 from the Charles County line to Barstow Road
- A two-lane reconstruction of MD 261 from MD 263 to Old Bayside Road

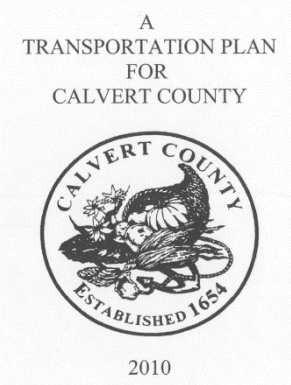
Calvert County Transit Development Plan

Required as a condition of receiving funds from the Maryland Department of Transportation Maryland Transit Administration (MDOT MTA), the Transit Development Plan is a document that guides public transportation improvements over a period of five to seven years. Calvert County's plan was most recently adopted in 2016. Key transit issues identified are limited service hour and frequency, transfer inefficiencies, lack of service to desired areas, and poor access to MTA Commuter Buses. Taking expected federal, state, and local funding into account, the document recommends short-term, mid-term, and long-term improvements as described below:

- Short-term improvements include a revision of the existing local routes and shuttles, enhanced public information and community outreach, and a dedicated transfer center
- Mid-term improvements include new service to the regional transfer center, an additional evening run from Prince Frederick, extended weekend hours, bus stop signs in Prince Frederick, and improved bus stop amenities
- Long-term improvements include increased route frequency and expanded demand-response service

Additionally, the plan recommends replacing transit vehicles at a rate of 3-4 per year.

Calvert County Transportation Plan 2010



Adopted in 1997, the first ever Calvert County Transportation Plan established specific improvements to meet County transportation needs and inform land use patterns through 2010. The Plan was written in response to the County's rapid population, housing, and job growth between 1960 and 1995. At the time, approximately 57% of Calvert County residents were employed outside of the county, mostly in Prince George's County and Washington, DC., and documented "growing pains" were increased congestion on state arterials and increased angle and fixed-object crashes on state roads. Recommendations from the Plan were proposed with Calvert County's projected future land use in mind, assuming 83% of all households would be located outside of Town Centers at a low density; all future commercial development would be in Town Centers. In anticipation of the County's significant increase in commuters, the main priority within the Plan was transportation systems management. This includes access control management and intersection improvements for MD 4 and MD 2/4, expanded park-and-ride lots, incentives for carpoolers, and roundabout assessment for traffic control in lieu of traffic signals. Additionally, numerous capacity upgrades were proposed for main arterials and collector roads. Extensions and new connections were proposed for the County's public transit system, focusing on increased service to Prince Frederick, the development of rapid transit, and transit stations within each Town Center. Finally, the Plan proposed a list of sidewalk connections and improvements, particularly focusing on Town Centers.

2040 Maryland Bicycle and Pedestrian Master Plan

Updated in 2019 by the Maryland Department of Transportation, the 2040 Maryland Bicycle and Pedestrian Master Plan presents a 20-year vision for improving bicycle and pedestrian access across the state. In its discussion of Southern Maryland, common threads are the need for better agency coordination, improved on-road facilities on state highways, and expanded sidewalk connectivity within communities. MD 4, MD 231, and MD 260 are the state highways within Calvert County that have existing bicycle signage. Future initiatives may focus on upgrading facilities on these roads and working with regional planning organizations and other partners to identify additional areas of opportunity.

Calvert County Land Preservation, Parks, and Recreation Plan 2018

The 2018 Calvert County Land Preservation, Parks, and Recreation Plan was adopted by the Board of County Commissioners. It replaces the previous plan adopted in 2014. The 2018 plan sets the goal of developing an interconnected system of pedestrian trails and bike paths throughout the county, also connecting to the greater Southern Maryland region. To do so, it is recommended that the County:

- Complete a countywide bicycle and pedestrian master plan
- Continue to evaluate existing linear corridors, rights-of-way, and other potential areas for future trail development

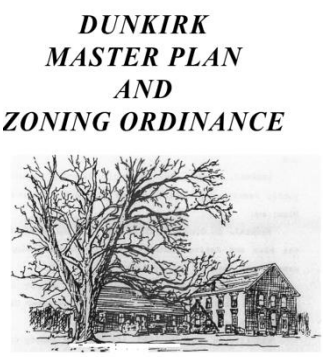
- Seek to acquire rights-of-way and open space through zoning, or subdivision entitlement process to utilize for future trail creation
- Create trails and paths within town center areas that connect with outlying parks and open spaces
- Continue to create, support, and promote public water trails in Southern Maryland
- Leverage lessons learned by neighboring counties to plan, construct, and operate multi-modal hiker/biker trails

Town Center Master Plans

Calvert County has seven Town Centers which have designated boundaries, master plans and zoning ordinances. These Town enters have helped the county concentrate commercial development in a few locations rather than scattered through the county, consistent with the County's effort to maintain the integrity of its rural areas. The seven Town Centers are Dunkirk, Owings, Huntingtown, Prince Frederick, St. Leonard, Lusby and Solomons from north to south. The municipalities Chesapeake Beach and North Beach are considered Town Centers; however, each has its own their own planning and zoning authority and their own comprehensive plans. The master plans for the seven Town Centers provide an overall framework of development for the Town Center and are an addendum to the Calvert County Comprehensive Plan. The Town Center plans provide land use and infrastructure recommendations as well as appearance guidelines that improve the state of each Town Center and preserve the unique characteristics of each one. General recommendations common in the Town Center plans include grid network roads that relieve the main roads of local traffic and congestion as well as streetscape projects and bike and pedestrian network expansions. Each Town Center has a master plan as summarized below.

Dunkirk Master Plan and Zoning Ordinance

This Master Plan and Zoning Ordinance was adopted in July of 1987 and revised seventeen times between 1992 and 2018, most revisions were made to the Zoning Ordinance regulations. The geographic location of Dunkirk is approximately 22 miles south of Washington, DC on MD 4; the Town Center includes approximately 200 acres of land.



Dunkirk's land use includes commercial and institutional uses. MD 4, arterial highway serves the Town Center. Two county collector roads also provide access to the east and west of the Town Center. Ferry Landing Road connects MD 4 and the Patuxent River. Ward Road, extends east and then north from Dunkirk, connecting MD 4 and Brickhouse Road. Several at capacity Park and Ride facilities are in Dunkirk.

The Dunkirk Town Center should serve as a visual marker much like a gateway, at the entrance to Calvert County. It is important that Dunkirk reflect the best features of the County's land use development philosophies and create a positive first image. Six policies established to achieve the goal of the Dunkirk Master Plan are as follows:

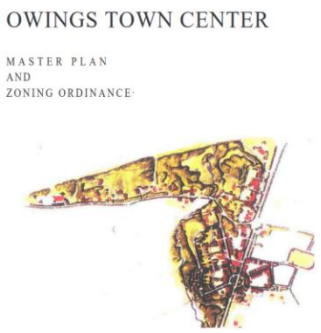
- The entire Town Center area of Dunkirk will be treated as an economic and aesthetic whole
- A "sense of place" with recognizable boundaries and unifying characteristics will be created in the commercial core of Dunkirk
- Established residential areas adjacent to the Town Center will be protected and enhanced
- Commercial development will be encouraged
- The efficiency and safety of MD 4 will be a primary goal

The relevant land use and transportation recommendations within Dunkirk are as follows:

- Dunkirk should meet the commercial and public facilities needs of area residents, rather than be a high-density residential area.
- Development on MD 4 should have the minimum impact on the service capacity and safety of major access route.
- An off-corridor circulation system is needed to prevent congestion and dangerous traffic points. The internal circulation system should provide sufficient access and a safe and efficient means of controlling traffic.
- New road locations need to be pre-planned for the benefit of the public and potential developers.
- The future level of service of Ferry Landing Road and MD 4 should be considered, as it is predicted to deteriorate.
- Residents of Ferry Landing Woods Road need a way to get to the Dunkirk District Park without going out onto MD 4.
- As Dunkirk develops, lowering speed limits within the Town Center limits may become necessary.
- Residents of Apple Green need a way to get to the shopping center on the east side of MD 4 without going onto MD 4. This route should not become a short cut for through traffic.

Owings Town Center Master Plan and Zoning Ordinance

The Owings Master Plan and Zoning Ordinance was adopted in June 2000. The Zoning Ordinance has been amended seven times between 2001 and 2018. The 75-acre Town Center is located along MD 260 (Chesapeake Beach Road) and MD 2 south of the Anne Arundel County line. Within Owings, the "Town Center" district is zoned to allow mixed use development; employment centers and residential zones border the Town Center district. The Town Center Plan provides a regulating plan which breaks the Town Center into three districts, the Core District, Village District and Edge District. Each district has designated guidelines for various land uses.

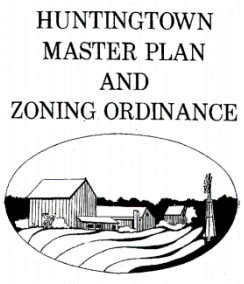


The Owings Town Center has environmental conditions that limit the number of developments that can take place with on-site sewerage disposals systems; however, a public sewerage system would be fully compatible with the recommendations in the Master Plan and allow for intensive use of the undeveloped Town Center lands and more intensive re-use of currently developed land. Wetlands and floodplains associated with Hall Creek occupies almost one-third of Town Center. These areas form a natural edge to the Town Center. The terrain in Owings varies from relatively flat to steep. The edge or MD 2 has the latter condition, which in effect, prevents connections to MD 2.
The Owings Town Center Master Plan focuses on a circle at the intersection of Chesapeake Beach Road and Thomas Avenue to integrate the employment center and the Town Center to manage circulation and conflict between the local and through traffic. The other transportation recommendations to address this vision are the following:

- Additional streets radiating from the proposed circle
- Construct a service lane along the south side of MD 260 (Chesapeake Beach Road) and interconnect parking lots in the rear of new buildings
- New residential street network south of Chesapeake Beach Road for future development

- New streetscape and infill development on Thomas Avenue
- Although MD Route 260 is recommended to be widened to four lanes on the State Highway Administration's Highway Needs Inventory, it is not recommended by the County or State Transportation Plan yet. Should future planning determine that MD 260 be widened through the Owings Town Center, guidelines should be followed for streetscape design standards

Huntingtown Master Plan and Zoning Ordinance



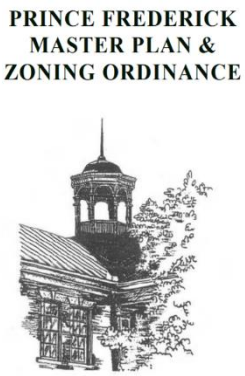
The Huntingtown Master Plan and Zoning Ordinance was adopted in October 1993 and revised fourteen times between 1994 and 2018, with the majority of revisions being made to the Zoning Ordinance regulations. At the time of the original plan, Huntingtown was a rural crossroads community centered around the intersection of Old Town Road (MD 524) and Hunting Creek Road (MD 521). The 304-acre Town Center is seven miles north of Prince Frederick, and 42 miles southeast of Washington, DC. Huntingtown was designated a minor Town Center by the Calvert County Comprehensive Plan in 1983. The Town Center has a rural characteristic with old tobacco barns, distinctive residential architecture, and large oak trees throughout the Town Center area. A small commercial center provides the basic amenities and a gathering place for the area.

Huntingtown lies along a ridgeline with streams draining to the east and south both of which are tributaries to Hunting Creek and to Cocktown Creek to the north. The Town Center has a topography that is gently to moderately sloping in the upland areas and steeply sloping along the deeply incised stream channels. Approximately 60 percent of the Town Center is forested, primarily in areas with slopes too steep to farm or removed from public roads. The remainder of the Town Center is either developed, in active agriculture, or open fields. All developments use individual septic systems and wells.

The Huntingtown Master Plan reflects the community's vision to protect and enhance the small-town character of Huntingtown with objectives such as accommodating future growth within the Town Center, encourage compatible commercial development while protecting existing residences and resolve traffic safety issues by establishing a safe and functional road systems. To address these objectives, the master plan makes infrastructure, land use districts, public spaces, and community appearance recommendations. Some of the relevant recommendations are as follows:

- Prohibit any new entrances to MD 2/4 along the Town Center's frontage.
- Permit and encourage a common sewage system for providing senior housing complex; conduct a study to evaluate a public sewer system.
- Monitor the need for a community water system. When needed, construct a small community water system with an elevated storage tank to provide a safe and reliable source of water and fire protection for the town center. This community water system should include a well field, a treatment facility, an elevated storage tank, and a distribution system.
- The thee land use districts proposed within Huntingtown Town Center are mixed use, neighborhood and residential districts.
- Encourage establishment of road network parallel to MD 2/4 to serve as a relief route.

Prince Frederick Master Plan & Zoning Ordinance



The Prince Frederick Master Plan was adopted in 1989. The plan has been amended once between its adoption and 2018. The Zoning Ordinance was adopted in 1992. Approximately 46 miles from Washington, DC and 64 miles from Baltimore, Prince Frederick is the capital of Calvert County and the largest Town Center. Prince Frederick is the major employment center in the county with the largest concentration of public and quasi-public services.

In 2013, a charette was held to consider changes to the Prince Frederick Town Center reflecting the changing demographics, competition for employment and commercial development, and housing patterns. The charette recommended increasing the Town Center to 2,218 acres to provide the proper land for growth around the activity centers in the area. The 2013 plan added some land on the north and west side of the town center and subtract some land from the south side of the town center. The charette also recommended creating three districts within the Town Center: a hospital district to the north, cultural district where the middle and high schools are located, and the civic district which includes the old town area and government center. The town center plan proposes new trails and road networks that include inter-Prince Frederick Town and regional connections. The road improvements include connections that help relieve MD 2/4 and connect the Community College without traveling on Hallowing Point Road.

St. Leonard Town Center Master Plan

The current St. Leonard Town Center Master Plan became effective on November 26, 2013. It replaced the initial St. Leonard Master Plan, which was adopted in 1995. St. Leonard is located about four miles south of the Prince Frederick Town Center, eight miles north of the Lusby Town Center and less than a mile from the Chesapeake Bay. The 335-acre Town Center is bounded on the west by MD 2/4 and on the east by the electric power easements from the Calvert Cliffs Nuclear Power Plant. The northern boundary is north of the St. Leonard Post Office and the southern boundary is north of the St. Leonard Elementary School. The updated Town Plan proposes increasing the size to 362 acres by expanding the Town Center to the southeast of Route 765 to include St. Leonard Elementary School. The Town Center is accessed from the north and south by MD 765. Access from the west is from Calvert Beach Road/Ball Road intersection with MD 2/4 and from the east from Calvert Beach Road. The Master Plan divides the Town Center into three areas from north to south: Mixed Use District, Core District, and Residential District.

The Master Plan identifies five goals, which are as follows:

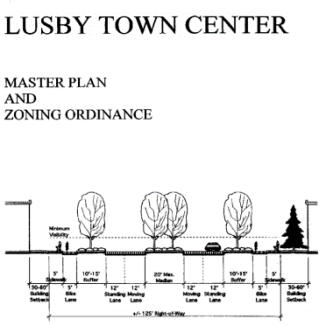
- Improve road circulation and traffic safety
- Promote an attractive image for the Town Center
- Maintain a high level of environmental quality while balancing economic development in the Town Center
- Provide adequate public facilities
- Encourage economic development that is compatible with the environmental, cultural, historical, and aesthetic character of St. Leonard

The following land use and transportation, policies, and actions were included in the Town Center Master Plan:

- Encourage mix of uses within the Core District.
- Reinforce the village character and encourage pedestrian circulation in the Mixed-Use District.
- To encourage walking, require sidewalks and street trees for new development and for redevelopment projects in the Mixed-Use and Residential Districts.
- Permit uses compatible with residential use in the Residential District.
- Preserve a 100-foot wooded buffer along MD 2/4.
- Consider grid network pattern parallel to St. Leonard Road and Calvert Beach Road, off the main corridors.
- Consider construction of a second access route with sidewalks and bikeways or shared use path to MD 765 from the communities lying east of St. Leonard, either south or north of the MD 765/Calvert Beach Road intersection.
- Develop a Town Center sidewalk and bicycle network.

Lusby Town Center Master Plan and Zoning Ordinance

The Lusby Town Center Master Plan and Zoning Ordinance was adopted in January 2002. The Zoning Ordinance has been amended eight times between 2003 and 2018. The Lusby Town Center, created in 1993, is about 270 acres in size; it is situated along the east side of MD 2/4 between Calvert Cliffs State Park and Solomons Island. The land uses within the Town Center include scattered single-family housing, commercial buildings, two public schools, the Southern Community Center including and a senior center and apartment buildings for senior citizens.



The master plan provides five zoning districts each with slightly different regulations. These districts are Institutional, Neighborhood Commercial, Village Commercial, Village Office-Residential, and Village Edge. The plan preserves and creates green spaces; setbacks along the planned parkway are planned to be large and preserved in an undeveloped state. The plan favors small businesses rather than big box retails and superstores and neither promotes nor encourages growth except where it has long been planned. Access along MD 2/4 is a critical plan element. It recommends no further curb cut access to MD 2/4 be allowed, focusing instead on creating interchanges and intersection reconfigurations in combination with parallel service roads along MD 2/4 to relieve the road of local traffic.

The master plan recommends the county and state to preserve strict highway access controls along MD 2/4 and Coster Road and should be proactive in providing infrastructure to support economic development and guide land development into the patterns envisioned in the plan and ensure that sidewalks are provided along all existing and new roads within the Town Center. The master plan also recommends the Town Center to reserve future road rights-of-way, reserve the planned village green, and typical road sections for the parkway and MD 765.

The Lusby Master Plan also outlines the general alignment of key roads and highways. These recommendations are as follows:

- Southern Connector Highway, sometimes referred to as “Rousby Hall Road Extended” would connect MD 2/4 with Rousby Hall Road at its intersection with Olivet Road. It would relieve congestion in the Town

Center by providing alternative access to some residential communities and land-locked parcels zoned ECTC and thus promote economic development. This project has been completed.

- Lusby Parkway is planned for phased construction and the section north of Rousby Hall Road has been constructed. Along with the Coster Road Extended, this project would promote development of the ECTC zoned lands by providing direct highway access from MD 2/4.
- Coster Road Extended would make ECTC lands readily accessible to MD 2/4.

Solomons Town Center Master Plan and Zoning Ordinance

The Solomons Town Center includes Solomons Island, the land to the north of the Island along MD 2/4 to the south side of Swaggers Point Road on the west side of MD 2/4, and approximately a quarter mile north of the intersection of Dowell Road and Trueman Road (MD 765), and the majority of the Dowell Peninsula. Access to the Solomons Town Center from St. Mary's County is via the Thomas Johnson Memorial Bridge. The first Solomons Master Plan was adopted in 1986. The new Solomons Town Center Master Plan was adopted in August 2009. The new Solomons Town Center Zoning Ordinance was adopted in September 2009 and has been amended seven times between 2009 and 2018. The Master Plan has been designed to protect and enhance the existing residential neighborhoods and to encourage the mixture of uses within the village core of Solomons Island; preservation of Solomons' water resources, heritage, and design character are important components of this Master Plan.

Solomons Town Center Master Plan and Zoning Ordinance

The Master Plan divides the area into six planning areas including the Solomons Annex of the Naval Air Station Patuxent River, Sandy Point area, Lore Road south to Charles Street, Lore Road north, Dowell Peninsula, and Swaggers Point. The Solomons Town Center includes some of the most highly developed waterfront in Calvert County. Waterfront property in the Town Center is in demand for financial investment as well as for quality of living reasons. Development should be constructed in harmony with the natural environment. The flood elevation requirements should be increased by two feet in this area. Certain shorelines in the Town Center have highly erodible soils, and development in these soils should be avoided wherever possible. It is also encouraged for Solomon Town Center adjacent waterfront property owners to mutually use the piers and/or mooring piles with one another.

Budgeted Improvements

The following documents were also reviewed, and a list of budgeted improvements is included in the maps accompanying this document:

- Fiscal Year 2018 Calvert County Operating and Capital Budget/Program (FY 2018 – 2024)
- Maryland Department of Transportation Consolidated Transportation Program for Fiscal Years 2018 - 2024
- Calvert-St. Mary's Metropolitan Planning Organization Transportation Improvement Program for Fiscal Years 2018 – 2021
- Calvert County Fiscal Year 2018 Program Open Space Annual Program

Traffic Impact Studies

This memorandum does not include traffic impact studies (TIS) prepared by private developers for the County as part of the development review process. TIS' may be used as a reference point in future memoranda relating to travel demand forecasting and proposed improvements.

ID	Project Description	Primary Road	From	To	Cross Street
1	Bike/ped improvements to MD 2 will be part of MDOT's efforts to ensure regional conectivity between points of interest. Facility improvements and the creation of maps and atlases	MD 2			
2	Bike/ped improvements to MD 2 will be part of MDOT's efforts to ensure regional conectivity between points of interest. Facility improvements and the creation of maps and atlases	MD 2	south county line	north county line	
3	4 lane widening	MD 4	Patuxent Point Parkway	MD 235 (St. Mary's County)	
4	Thomas Johnson Bridge replacement	MD 4	Thomas Johnson Bridge		
5	interchange construction	MD 2			Southern Connector Road
6	interchange construction	MD 2			MD 497
7	interchange construction	MD 2			Dowell Road
8	Calvert County Transit Center				
9	resurface 68 miles of existing county collector roads and 259 miles of land access roads by 2010	all collector roads			
10	5th street extention and reconstruction: improve safety, add shoulders and sidewalks, and improve sight and stopping distances	5th street	Boyds Turn Road	North Beach Town Line	
11	extension- construct new road to commercial standards, section 2 of inner loop	Prince Frederick Boulevard			
12	reconstruct road to commercial standards, widen existing roadway, add sidewalks	West Dares Beach Road	MD 2/4	existing terminus	
13	sections 3-5, construct new road to commercial standards	Prince Frederick Loop Road			
14	extension- construct new road to commercial standard	West Dares Beach Road	existing terminus	Williams Road	
15	Reconstruct road to primary collector or commercial standards	Williams Road	MD 231	proposed extension of West Dares Beach Road	
16	widen travel lanes, add shoulders	Dowell Road	MD 2/4	Lord Calvert Yacht Club	
17	add bike/ped path	Dowell Road			
18	widen travel lanes, add shoulders	Skinners Turn Road	MD 2	MD 4	
19	construct new road	Outer Loop of Prince Frederick Loop Road			
20	widen travel lanes, add shoulders, improve sight distance, upgrade road	German Chapel Road	MD 231	MD 2/4	
21	widen travel lanes, add shoulders, improve sight distance, upgrade road, improve intersections along route granting priority to through movement of traffic	Stinnett Road, Emmanuel Church Road, Wilson			
22	extend road, construct to primary collector or commercial standards, new alignment (closed-section)	Rousby Hall Road	Olivet Road	MD 765	
23	construct new road	new road	Boyds Turn Road	MD 260	
24	extend MD 765, including bike/ped	MD 765	Dowell Road	Spinnaker	
25	grade separation	MD 4			MD 260
27	add shoulders, widen travel lanes to 12', upgrade to arterial standards	MD 261	Christiana Parran Road	Plum Point Road	
28	widen travel lanes	MD 231	German Chapel Road	MD 2/4	
29	widen to 6 lanes	MD 2/4	Stoakley Road	south 2.8 miles	
30	widen to 4 lane divided highway, possibly a continuous left turning lane	MD 231	German Chapel Road	MD 2/4	
31	widen to 6 lanes	MD 2/4	Stoakley Road	Plum Point Road	
32	grade separation	MD 4			MD 260
33	grade separation	MD 4			Ward Road
34	grade separation	MD 4			MD 2
35	grade separation	MD 2/4			Cox Road
36	grade separation	MD 2/4			north of Stoakley
37	grade separation	MD 2/4			Steeple Chase
39	grade separation	MD 2/4			Ball Road
40	grade separation	MD 2/4			Dowell Road
41	traffic calming measures to reduce speed and improve pedestrian safety	Cassell Boulevard	MD 402	existing terminus	
42	intersection improvement - congestion and safety concerns	Rousby Hall Road			Olivet Road
43	intersection improvement - poor intersection geometry and safety concerns	Huntingtown Road			Hunting Creek Road
44	consider adding a double left turn and storage area and install flashing warning light	MD 4	MD 4	MD 260	Chesapeake Beach Road
45	add exclusive right turn lane to MD 2/4 southbound	MD 2/4			Stoakley
47	legally restrict use during peak traffic periods, monitor effectiveness, consider closing permanently	Main Street	Commerce Lane	MD 2/4	
48	intersection improvement- poor intersection geometry, congestion and delay	Main Street			Church Street and Armory Road
49	intersection improvement- poor sight distance for left turns from eastbound Duke Street	Main Street			Duke Street
50	consider restricting left turns to southbound MD 2/4	MD 765			MD 2/4
51	add exclusive right turn lane to MD 231 southbound	MD 231			Stafford Road
52	intersection improvement- geometry and safety concerns	Boyds Turn Road			MD 260
53	expand existing commuter parking lots and build two new lots in Solomons and St. Leonard - 270 total new spaces				
54	northbound, adjust vertical alignments, widen outside shoulder	MD 2/4	Lyons Creek Road	MD 260	
55	southbound, adjust vertical alignments, widen outside shoulder, install outside shoulder where missing	MD 2/4	Lyons Creek Road	Chaneyville Road	
56	northbound, adjust vertical alignments, widen outside shoulder	MD 2/4	MD 262	1000' south of Chaneyville Rd	
57	northbound, adjust vertical alignments	MD 2/4	Sheckells Road	Llewelyn Lane	
58	northbound, adjust vertical alignments		Sheckells Road	Llewelyn Lane	
59	construct new road to primary collector standards (closed section)	West Ward Road	MD 4	Landing Lane	
60	construct new road to secondary collector standards (closed section)	Kirksville Lane	existing terminuns	West Ward Road	
61	construct new road permitting on-street parallel parking	Walnut Crossing	Walnut Creek subdivision	Hunting Creek Road	
62	construct new road permitting on-street parallel parking	Hunting Creek Road - Old Town Road Connector	MD 2/4	Hunting Creek Road	
63	construct new road permitting on-street parallel parking	"Old Field Road"	Hawk Hill Drive	Church Street	
64	construct new road to secondary county collector standards	"Long Beach Road Extended"	Calvert Beach Road	proposed Maryland Avenue	
65	construct new road	Maryland Avenue/"South Street"	proposed extension of Long Beach Road	MD 765	
66	construct new road	"East Avenue"	Calvert Beach Road	proposed extension of Long Beach Road	
67	construct new road to commercial standards	"Coster Road Extended"	MD 765	proposed Rousby Hall Road extended	
69	new bus stop in Prince Frederick Town Center				

ID	Project Description	Primary Road	From	To	Cross Street
70	new rapid transit route between Prince Frederick and Hughesville, serving the Route Five Flyer to DC				
71	potential rapid transit	MD 260	Chesapeake Beach	Annapolis	
72	potential rapid transit	MD 2	Chesapeake Beach	Annapolis	
73	potential rapid transit	MD 2/4	Prince Frederick	Patuxent Naval Air Station	
74	express bus		Chesapeake Beach	North Beach and Dunkirk Center	
75	transit stations in each town center				
76	Dunkirk town center - construct bicycle path along proposed access road	proposed access road	Ferry Landing Road	Dunkirk District Park	
77	Huntingtown- sidewalks, install street trees in developed commercial portions of Mixed Use District				
78	Huntingtown- secure easement for hard surface trail		business district	Huntingtown Elementary School	
79	Prince Frederick- sidewalk	Main Street	Town Center south boundary	Church Street	
80	Prince Frederick- sidewalk	Church Street	Main Street	MD 2/4	
81	trail system		Prince Frederick	natural areas outside of the Town Center	
82	sidewalk, street trees, lighting	MD 765	within Village District - Subarea B		
83	sidewalk	MD 2	Lore Street	northeastern end of Farren Ave on east side of highway	
84	sidewalk	Charles Street	Lore Street	northeastern end of Farren Ave on east side of highway	
85	sidewalk	Charles Street	Farren Ave	MD 2	
86	sidewalk	MD 2	Charles Street	Lore Street	
87	sidewalk	MD 765	Lore Street	Spinnaker Way	
88	sidewalk	MD 765	Spinnaker Way	Newtown Road	
89	sidewalk	Newtown Road	MD 2/4	Dowell Road	
90	sidewalk	Dowell Road	MD 765	terminus	
91	riverwalk	Patuxent River	Solomons Island		
92	widening and replacement of bridge	Thomas Johnson Bridge and MD 4	MD 235	MD 2	
93	widen to 6 lanes with access control and turning movement restrictions, interchanges at the north and south termini. Included in HNI	MD 2/4	south of Commerce Lane	north of steeple chase drive	
94	widen to 6 lanes with access control and turning movement restrictions, interchanges at the north and south termini. Included in HNI	MD 2/4	north of steeple chase drive	north of Stoakley Road	
95	raise 800 ft of MD 261 up 3.5 feet to a level above the floodplain	MD 261	9th Street	Anne Arundel County line	
96	corridor study	MD 231	Mason Road	Seagull Beach Road	
97	LOS improvements- westbound left turn lane	MD 231			Mason Road
98	LOS improvements- intersection re-alignment and improvements	MD 231			Stafford Road
99	LOS improvements- westbound left turn lane	MD 231			Thunder Hill Drive
100	LOS improvements- westbound left turn lane	MD 231			Spring Hill Court
101	LOS improvements- entrance improvements southbound lane exit	MD 231			HallOwings Point Park
102	LOS improvements- park entrance improvements, alternate park entrance	MD 231			Jibsail Drive
103	LOS improvements- park entrance improvements, alternate park entrance	MD 231			Seagull Beach Road
104	sight distance improvements	MD 261			Beach Drive
105	safety study, potential for a roundabout	MD 261			Ponds Woods Drive
106	future project to extend the existing acceleration and deceleration lanes	MD 4			Dunleigh Drive
107	Lusby Town Center Streetscape- fill gaps after developers have completed their projects	MD 760	east of MD 765	west of MD 765	
108	Lusby Town Center Streetscape- fill gaps after developers have completed their projects	MD 765	Appeal Lane	MD 760	
109	widening and replacement of bridge	Thomas Johnson Bridge and MD 4	MD 235	MD 2	
110	sidewalks	MD 261	Beach Elementary School	Chesapeake Village neighborhood	
111	sidewalks	Old Bayside Road	Beach Elementary School		
112	crosswalk	MD 261			Chesapeake Village and Bayfront Park
113	interchange construction	MD 2			Southern Connector Road
114	interchange construction	MD 2			MD 497
115	interchange construction	MD 2			Ball Road/Calvert Beach Road
116	divided highway reconstruct with access control improvements	MD 2	MD 264	MD 765 south of Prince Frederick	
117	divided highway reconstruct	MD 2	MD 765 south of Prince Frederick	north of Stoakley Road	
118	divided highway reconstruct with access control improvements	MD 2	north of Stoakley Road	MD 4	
119	bridge construct	MD 4	St. Mary's County line	11	
120	divided highway reconstruct with access control improvements	MD 4	MD 2	Anne Arundel County line	
121	divided highway reconstruct	MD 231	Charles County line	Barstow Road	
122	multi-lane reconstruct	MD 231	Barstow Road	MD 2/4	
123	multi-lane reconstruct	MD 260	MD 4	Anne Arundel County line	
124	multi-lane reconstruct	MD 260	Anne Arundel County line	begin divided highway	
125	2 lane reconstruct	MD 261	MD 263	Old Bayside Road	
126	multi-lane reconstruct	MD 261	Old Bayside Road	1st Street	
127	upgrade and widen to 6 lane, including bike/ped	MD 2/4	Fox Run Boulevard	MD 231	
128	replace bridge over Fishing Creek, bike/ped facilities	MD 261			Fishing Creek
129	study to upgrade and widen MD 2/4 to 6 lane divided highway	MD 2/4	north of Stoakley Road	south of MD 765A	
130	study to upgrade, including Governor Thomas Johnson Memorial Bridge, bike/ped facilities	MD 4	MD 2	MD 235	
131	resurface/rehabilitate	MD 2	Coster Mill Bridge Road; MD 264	Calvert Cliff Parkway; Commerce Drive	
132	2 lane reconstruct	MD 261	Bay Avenue	Anne Arundel County line	
134	Four-lane widening	MD 4	Thomas Johnson Bridge	MD 235	
135	interchange construction	MD 4			MD 235

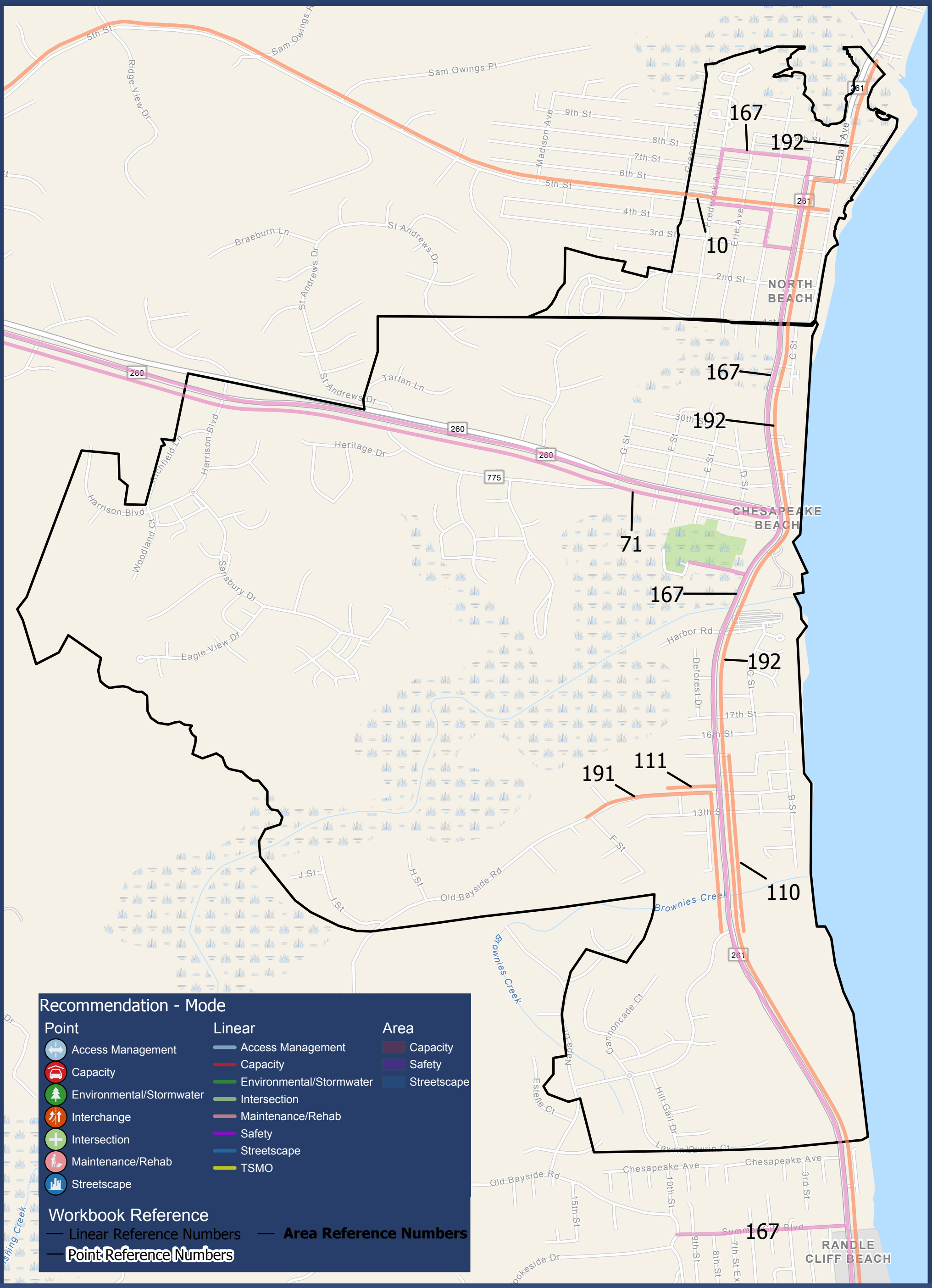
ID	Project Description	Primary Road	From	To	Cross Street
136	Four-lane widening	MD 4	Thomas Johnson Bridge	Patuxent Point Parkway	
143	Study to upgrade MD 4 between MD 2 and MD 235, including the Thomas Johnson Bridge and MD 235 Intersection (2.91 miles). Sidewalks will be provided where appropriate for pedestrians.	MD 4	MD 2	MD 235	
144	Design of intersection, bridge, and drainage improvements along MD 5 from MD 246 to MD 471.	MD 5	MD 246	MD 471	Point Lookout Road
145	MD 5, Point Lookout Road Bridge over Eastern Branch: Replace structure 18008 over Eastern Branch	MD 5	Point Lookout Road Bridge		
150	Southern Maryland Rapid Transit project to provide fixed-route, high-capacity transit service in the MD Route 5/ US 301 corridor from the Branch Avenue Metro Station to Waldorf/White	MD 5 / US 301	Branch Avenue Metro Station	Waldorf/White Plains	
151	Upgrade MD Route 2/4 providing wideining to six lanes with access controls and turning restrictions.	MD 2/4	MD 765A / Industry Lane	North Auto Drive	
154	Community safety and enhancement project, TIP reference RE Urban Reconstruct	MD 231	MD 765	Armory Rd	
163	Resurfacing of MD 2; Cox Road to Ponds Wood Road	MD 2	Cox Road	Ponds Wood Road	
167	eliminate service to Dares Beach, add additional evening run	North Route			
168	add service to Dares Beach, Ponds Wood Rd, reduce daily trips from 5 to 3	Dunkirk Route			
169	layover at Patuxent Plaza, eliminate service to Ranch Club, serve White Sands in both directions, add additional evening run	South Route			
170	eliminate service to White Sands but now served on route 4 southbound and northbound, timed transfer at Southern Pines Community Center for trips to Prince Frederick	Mid County Route			
171	convert to one loop, hourly service	Lusby Shuttle			
172	Shuttle I and II operate in the same direction, 30 minute headways, 7 min layover at Calvert Pines Senior Center	Prince Frederick Shuttle I			
173	Shuttle I and II operate in the same direction, 30 minute headways, 7 min layover at Calvert Pines Senior Center	Prince Frederick Shuttle II			
174	new route connecting Prince Frederick to Charlotte Hall, 1 hour headways	Charlotte Hall Route			
175	current transfer center at Calvert Pines Senior Center, build dedicated transfer center at New College of Southern Maryland in Hughesville	Transfer Center Development			
178	beacon way drainage repair				
179	Calvert Marine Museum Turning Lane				
180	Gunsmoke Trail/Lusby Parkway Connection	Gunsmoke Trail			Lusby Parkway
181	Prince Frederick Loop Rd - North and South Overpasses	Prince Frederick Loop			
182	Skinners Turn Road Phase 2	Skinners Turn Road			
183	Ward Road Improvements	Ward Road			
184	reconstruct intersection to improve sight distance and other safety issues	Barstow Road			Leitches Wharf Road
185	extend Little Cove Point Road for 150 feet to connect to Bunkhouse Road	Little Cove Point Road Extended			Bunkhouse Road
186	connect Calvert Middle School connecting with Fox Run Blvd, MD 402, and Armory Rd	Prince Frederick Loop Road			
187	traffic study for potential roudabout	Prince Frederick Loop Road			Traskers Blvd
188	upgrade and widen road, horizontal and vertical roadway alignments, sight distance, intersection an drainage improvements. Phase I	Skinners Turn Road	MD 4	MD 2	
189	widen roadway (4 travel lanes, no center turn lane) with curb and gutter, sidewalks, safety improvements	West Dares Beach Road - Improvements	MD 2/4	Prince Frederick Blvd	
190	new sidewalk along east side of road (2,130 linear ft)	Solomons Island Road	440 ft north of Langley Lane	Alexander Street	
191	new sidewalk connection for students traveling to Chesapeake Beach Elementary School	MD 261	F Street	north of Chesapeake Village Blvd	
192	North Beach Elevated Walkway, shared-use path	MD 261			
194	War of 1812 Star-Spangled Banner Trail: access to War of 1812 sites, connect Flag Ponds Nture Park, Cove Point Park, Calvert Cliffs State Park, Annmarie Garden, and Calvert Marine Museum.				
195	Chesapeake Beach Railway Trail: 7.7 miles along old railway. The County will be responsible for land acquisition and development outside the Chesapeake Beach town boundary.	along old railway	Chesapeake Beach	Richfield Station	
195	Location of existing entrances and crossovers is not ideal and should be improved within the Dunkirk Town Center.				
196	North Beach Nature Trail Section A: connect overlook and Frederick Avenue thorugh recently acquired parcel of land		A: observation area of overlook in Borth Beach B: 9th Street and Bay Avenue	A: Burnt Oaks B: 0.4 mile north to Anne Arundel County line, then to Rose Haven	
196	Chain link fence along Route 4 is unsightly and detracts from the appearance of the approach to the Dunkirk Town Center.	MD 4			
197	Baltimore & Drum Point Railroad Trail, 34 miles, may overlap with Star-Spangled Banner Trail	acquisition old railway development: along Armory Road	acquisition: Owingss development: north of Calvert Memorial Hospital behind the	acquisition: Drum Point development: King Memorial Park	
197	in the future, the LOS at the intersection will deteriorate and additional steps will need to be taken to improve traffic circulation at this intersection	MD 4	Ferry Landing Road		
198	Old Bayside Road Trail, access to Fishing Creek Park, possibility of connection with county park and to Chesapeake Beach Railway Trail	Old Bayside Road	Beach Elementary	north side of road, 1500 linear feet to just south of E Street, long term goal of extending trail	
198	When park and ride facilities in the Route 4 corridor are near capacity, new facilities will be constructed at or just north of Dunkirk	MD 4			
199	develop sidewalk, recreational amenities, and connections to shopping center	Main Street			
199	To increase the efficiency of the County Rescue Service, a helicopter landing pad should be constructed in the Third District				
200	The Route 4 corridor near the Dunkirk Town Center is bare and monotonous. Landscaping along Route 4 will enhance the appearance of the Town Center and promote traffic safety by breaking	MD 4			
201	Residents of Ferry Landing Woods Road need a way to get to Dunkirk District Park without going out onto Route 4.	Ferry Landing Woods Road			
202	Residents of Apple Greene need a way to get to the shopping center on the east side of Route 4 without going out onto Route 4. It is important that such an access road not become a short cut	Apple Greene Neighborhood			
203	Allow property owners to retail the current access drive to the Penwick House property and also allow the owners to provide for an additional drive at the property line between the Penwick	Penwick House Property			
204	Allow no more than two additional access points from northbound MD 4 to adjacent developments between Penwick Lane and the northern edge of the Town Center boundary	Penwick Lane	MD 4		
205	Do not permit additional entrances on the west side of Route 4 south of Ferry Landing Road. Limit the number of access points on the east side of Route 4, south of the Ward Road	MD 4	Ferry Landing Road	Ward Road	
206	Improve internal traffic control in the exxisting shopping center on the west side of Route 4 by better definition of entrances and exits. Encourage strict enforcement of parking laws on Route	MD 4			
207	Locate a park and ride lot in the vicinity of the fire station. Construct a helicopter landing pad in conjunction with the park and ride lot. Also, consider expanding the lot at the Dunkirk Park, if it	MD 4	Ferry Landing Road		
208	Landscape Route 4	MD 4			
209	Construct an access road from Ferry Landing Road to the Dunkirk District Park		Ferry Landing Road	Dunkirk District Park	
210	Allow left hand turns from the southbound lane of Route 4 into the new road across from the entrance to the park as well as into Apple Greene	MD 4	Access Rd across from District Park	Apple Greene	
211	Require Cortland Lane to be extended to Apple Way and provide a connecting road between Apple Way and Park Lane. The roads should be designed with stop signs and T intersections to	Cortland Lane	Apple Way		
212	Extend the deceleration lane on the southbound lane of Route 2/4 from the crossover at Apple Way to a point opposite the exit to County Plaza Shopping Center.	MD 2/4	Apple Way		
213	New frontage rd on Chesapeake Beach Rd, west of Old Solomons Island Rd with interconnected parking lots in rear of new structures	Chesapeake Beach Rd	Old Solomons Island Road	Solomons Island Road	
215	New hike trail on abandoned track bed south of Chesapeake Beach Rd				
216	Residential street network for future development, south of Chesapeake Beach Rd				
217	New streetscape and infill structures on Thomas Avenue	Thomas Avenue	Chesapeake Beach Rd	Old Solomons Island Road	
218	New sidewalks on Old Solomons Island Rd, south of Chesapeake Beach Rd	Old Solomons Island Road	Thomas Avenue	Owingss Hill Ct	
219	Prohibit any new entrances to MD 2/4 along the Town Center's frontage.	MD 2/4			
220	Extend Old Town Road south through SHA's Park-n-Ride providing access to the two churches and possibly Carroll-Victoria Lodge from this frontage road as opposed to MD 2/4. This will allow	Old Town Road	Cox Road	Athena Ln	
221	Consider relocation of the park-n-ride to the lot north of Huntingtown Plaza. This central location is ideal for a park-n-ride. Acquisition of this parcel would also preserve it for the Future				
222	Encourage establishment of a network of roads parallel to MD 2/4 to serve as a relief route allOwings local traffic to access Huntingtown without traveling on MD 2/4.	MD 2/4	Ponds Wood Rd	Bowie Shop Rd	

ID	Project Description	Primary Road	From	To	Cross Street
223	Provide road connection between Walnut Creek Subdivision and Town Center.		Hunting Creek Rd	Cross Creek Dr	
224	Provide an integrated pedestrian pathway system to help unify the town. Provide sidewalks throughout the Mixed Used and Neighborhood Districts linking the commercial, residential, and				
226	Proposed regional trail network in Prince Frederick Town Center from Prince Frederick to the River Trail (west of town center north of Community College)				
227	Proposed regional trail, Baltimore-Drum Point Railroad Trail in Prince Frederick Town Center (north to south of Town Center)				
228	Proposed on-street multimodal network, on HallOwings Pt Road from Community college to Dares Beach Rd	HallOwings Pt Rd	western edge of Town Center	Dares Beach Rd	
229	Proposed on-street multimodal network, on Dares Beach Rd from the High School/Middle School edge to HallOwings Pt Rd	Dares Beach Rd	Edge of high school	HallOwings Pt Rd	
230	Proposed on-street multimodal network, on Auto Dr/Prince Frederick Blvd from Solomon Island Rd to HallOwings Pt Rd	Prince Frederick Blvd	Solomon Island Rd	HallOwings Pt Rd	
231	Proposed on-street multimodal network, on Main St from HallOwings Pt Rd to MD 2/4	Main St	HallOwings Pt Rd	MD 2/4	
232	Proposed on-street multimodal network, from MD 2/4 the Hospital to Chesapeake Blvd and edge of old and new middle school sites to Dares Beach Rd		Solomon Island Rd	Dares Beach Rd	
233	Proposed street network parallel to MD 2/4, north of Community College and grid patterns off of main corridors. Slide 39 has all of linework				
234	Proposed traffic signal at HallOwings Pt Road and Main Street.	HallOwings Pt Rd			Main St
235	Proposed traffic signal at MD 2/4 and Auto Dr (North of hospital)	MD 2/4			Auto Dr
236	Proposed traffic circle at Dares Beach Rd and Fox Run Blvd	Dares Beach Rd			Fox Run Blvd
237	Proposed roundabout at HallOwings Pt Rd and Prince Frederick Blvd	HallOwings Pt Rd			Prince Frederick Blvd
239	Preserve a 100-foot wooded buffer along MD 2/4				
240	Proposed grid network parallel to St Leonard Road and Calvert Beach Road, grid patterns off of main corridors. Page 31, figure 14 has all of linework				
241	More parking is needed within the Town Center	Town Center			
242	Continue to improve the safety and capacity of the Ball Road/ MD 2/4 intersection as needed.	MD 2/4			Ball Rd
243	Consider construction of a second access route to MD 765 from the communities lying east of St. Leonard, either south or north of the MD 765/Calvert Beach Road Intersection. The second	Calvert Beach Rd			
244	Continute providing fixed route service to the St. Leonard Town Center				
245	Consider reestablishing service to Calvert Beach and Long Beach, if there is funding available and ridership demand.				
246	Continue providing demand response transit service to areas south of Prince Frederick, including the St. Leonard Town Center.				
247	Provide shelter for transit users withiin the Town Center. The shelter should be located in the Core District				
248	Coordinate local bus service times with the MTA schedules				
249	Designate a fixed bus stop and identify the location with a sign.				
250	Extend the sidewalks along St. Leonard Road (MD 765) in the Town Center as County funding permits. Pursue State funding for sidewalk construction along St. Leonard Rd in the Town Center	St. Leonard Rd			
251	Construct a sidewalk on the south side of the Dowell House from Calvert Drive to Maryland Avenue, to provide a connection between the recreation area, the Dowell House parking lot, and	Dowell House	Calvert Dr	Maryland Ave	
252	Continue requiring pedestrian street lighting in the Core District.				
253	Work with property owners and the Calvert Beach and Long Beach communities on possible ways to make Calvert Beach Rd and Long Beach Rd safer for bicycling.				
254	Install/maintain bicycle racks at St. Leonard Recreation Area and St. Leonard Polling House Park.				
255	An interchange at MD 2/4 and Cove Point Rd	MD 2/4			Cove Point Rd
256	Parallel service road along west side of MD 2/4 starting at Sweetwater Lane	MD 2/4	Sweetwater Lane		
257	Reconfiguration of Rousby Hall Rd / MD 2/4 into a right-in / right-out intersection	MD 2/4			Rousby Hall Rd
258	An overpass at Coster Rd	Coster Rd			MD 2/4
259	An interchange at MD 2/4 and the proposed southern connector highway	MD 2/4			Southern connector highway
260	Allow for conversion of existing Trueman Rd from Appeal Ln to Coster Rd into a Main Street	Trueman Rd	Appeal Ln	Coster Rd	
261	Allow faster moving pass-through traffic to directly access Rousby Hall Rd or the southern connector highway preventing congestion in the Town Center.	Rousby Hall Rd			
262	Enhance rural character of the area by preventing traffic congestion and providing wooded two-lane highway	MD 2/4			
263	Provide road improvements that the ECTC zone will need in order to develop as planned for a campus-style office employment center	MD 2/4			
264	Provide appropriate redundancy in the local road network so that traffic can be handled safely and efficiently.	MD 2/4			
265	Make road improvements to Dowell Rd, including widening of the roadway, construction of sidewalks, and designation of bike lanes.	Dowell Rd			
266	Construct a multipurpose path for pedestrians and bicyclists along Dowell Rd, in addition to the bike lanes and sidewalks, to encourage bicycle use, promote pedestrian safety, and reduce car	Dowell Rd			
267	Modification to make a more prominent and attractive bridge at the "tide box" to recreate a "sense of place" in historic Solomons and provide an attractive, functional and historic entryway.	"Tide Box"			
268	Conduct a parking use study of Planning Area C. Include in the study the parking of vehicles with boat trailers.				
269	Restrict parking to vehicles only at Solomons Waterfront Park.				
270	Prohibit overnight parking at Solomons Waterfront Park.				
271	Pursue renewing the lease for the public parking lot behind Our Lady Star of the Sea Catholic Church when the initial term expires in 2017.				
272	Sufficient land should be purchased or leased near the Museum to provide additional parking spaces.				
274	Continue providing fixed route services to the Solomons Town Center.				
275	Continue providing demand response transit service to areas south of Prince Frederick, including the Solomons Town Center.				
276	Investigate the possibility of providing shuttle bus services to Solomons during the summer season and on weekends during the spring and fall seasons.				
277	Construct sidewalks that connect the commercial and residential areas along Solomons Island Road from Lore Road north to Dowell Road	Solomons Island Road	Lore Rd	Dowell Rd	
278	Construct sidewalks along Dowell Road	Dowell Rd			
279	Construct a sidewalk that ties in the Solomons Annex of the Patuxent River Naval Air Station with the public boat ramp area under the Governor Thomas Johnson Memorial Bridge and the				
280	Request the Maryland SHA to construct a crosswalk at the intersection of MD 2/4 and Patuxent Parkway	MD 2/4			Patuxent Pkwy
281	Construct sidewalks along Newtown Road	Newtown Rd			
282	Consturct proposed bikeway in Solomons Town Center				
283	Possible traffic light at Ward Road and Proposed Park Drive	Ward Road			Proposed Park Dr
284	Possible traffic light connecting proposed connection morth of Country Plaza to west of Fire Station (map on page 19)	Ward Road			

Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Chesapeake Beach & North Beach - Ped/ Bike/ Trail/ Transit



Recommendation - Mode

Point
- Access Management
- Capacity
- Environmental/Stormwater
- Interchange
- Intersection
- Maintenance/Rehab
- Streetscape

Linear
- Access Management
- Capacity
- Environmental/Stormwater
- Intersection
- Maintenance/Rehab
- Safety
- Streetscape
- TSMO

Area
- Capacity
- Safety
- Streetscape

Workbook Reference

— Linear Reference Numbers — **Area Reference Numbers**

— Point Reference Numbers

SABRA & ASSOCIATES
Engineering Innovative Solutions

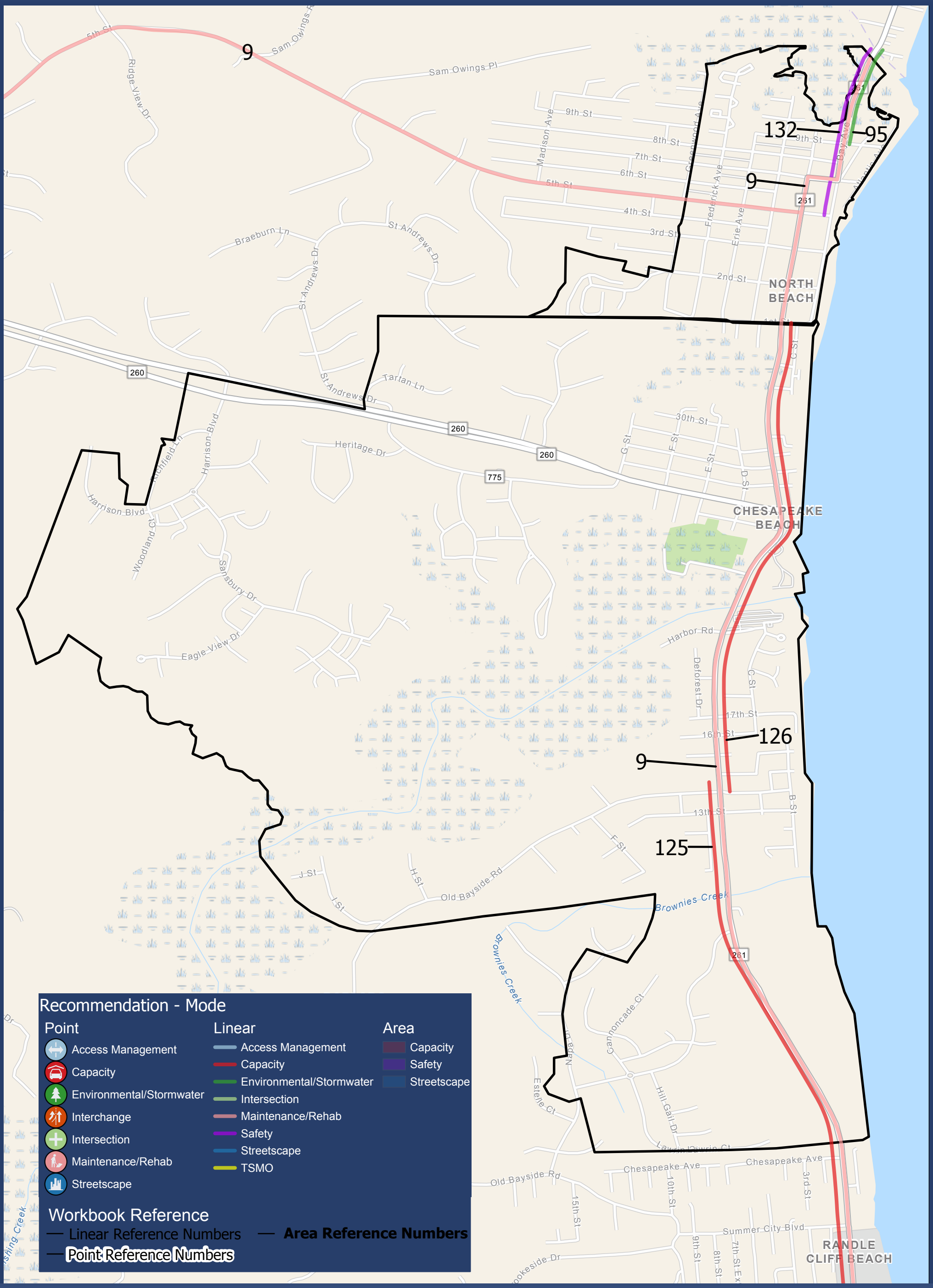
0 0.13 0.25 0.5 0.75 1 Miles

N

Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Chesapeake Beach & North Beach - Roadway



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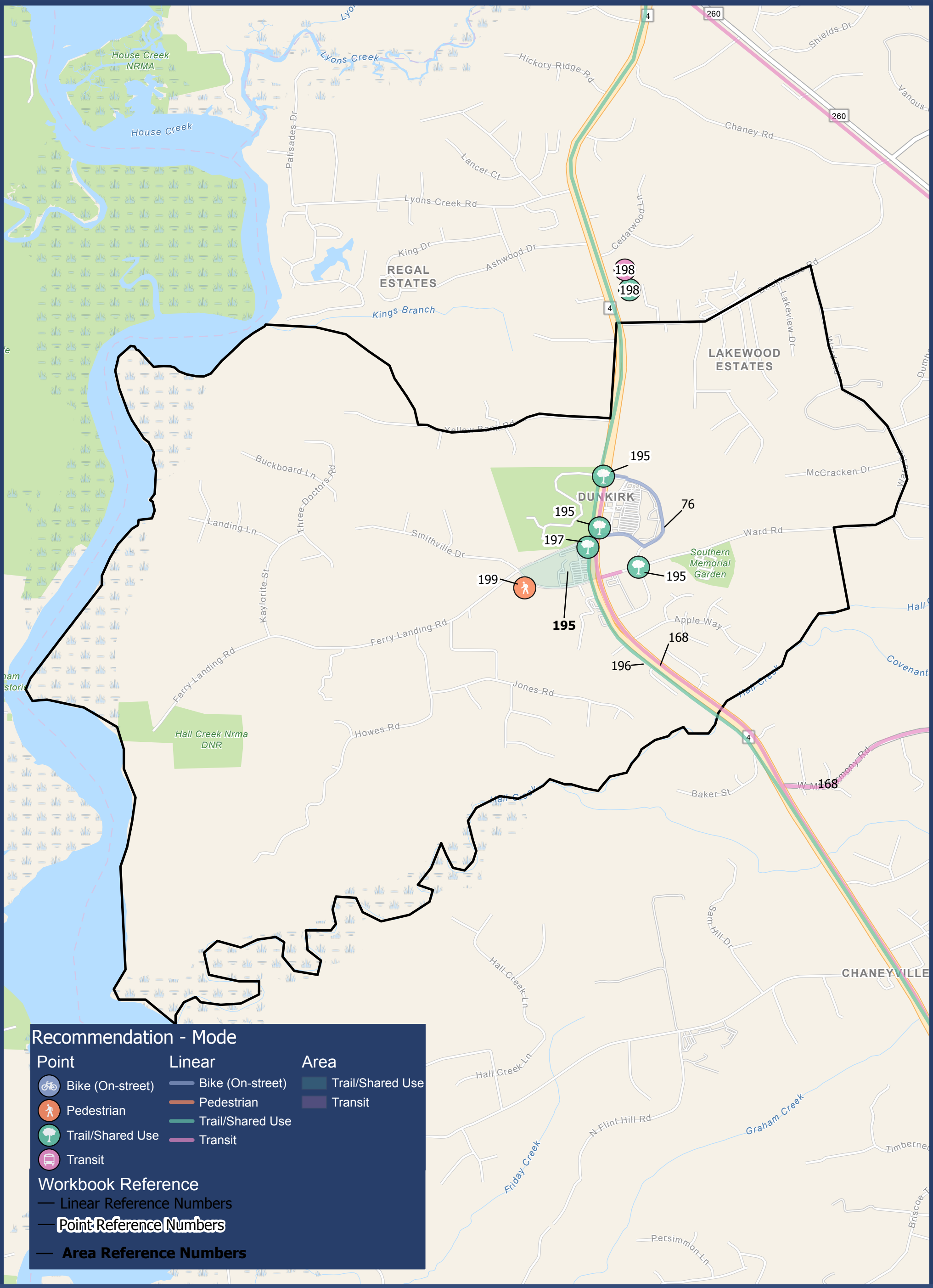
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Dunkirk - Roadway



Recommendation - Mode

Point
- Bike (On-street)
- Pedestrian
- Trail/Shared Use
- Transit

Linear
- Bike (On-street)
- Pedestrian
- Trail/Shared Use
- Transit

Area
- Trail/Shared Use
- Transit

Workbook Reference

- Linear Reference Numbers
- Point Reference Numbers
- **Area Reference Numbers**

SABRA & ASSOCIATES
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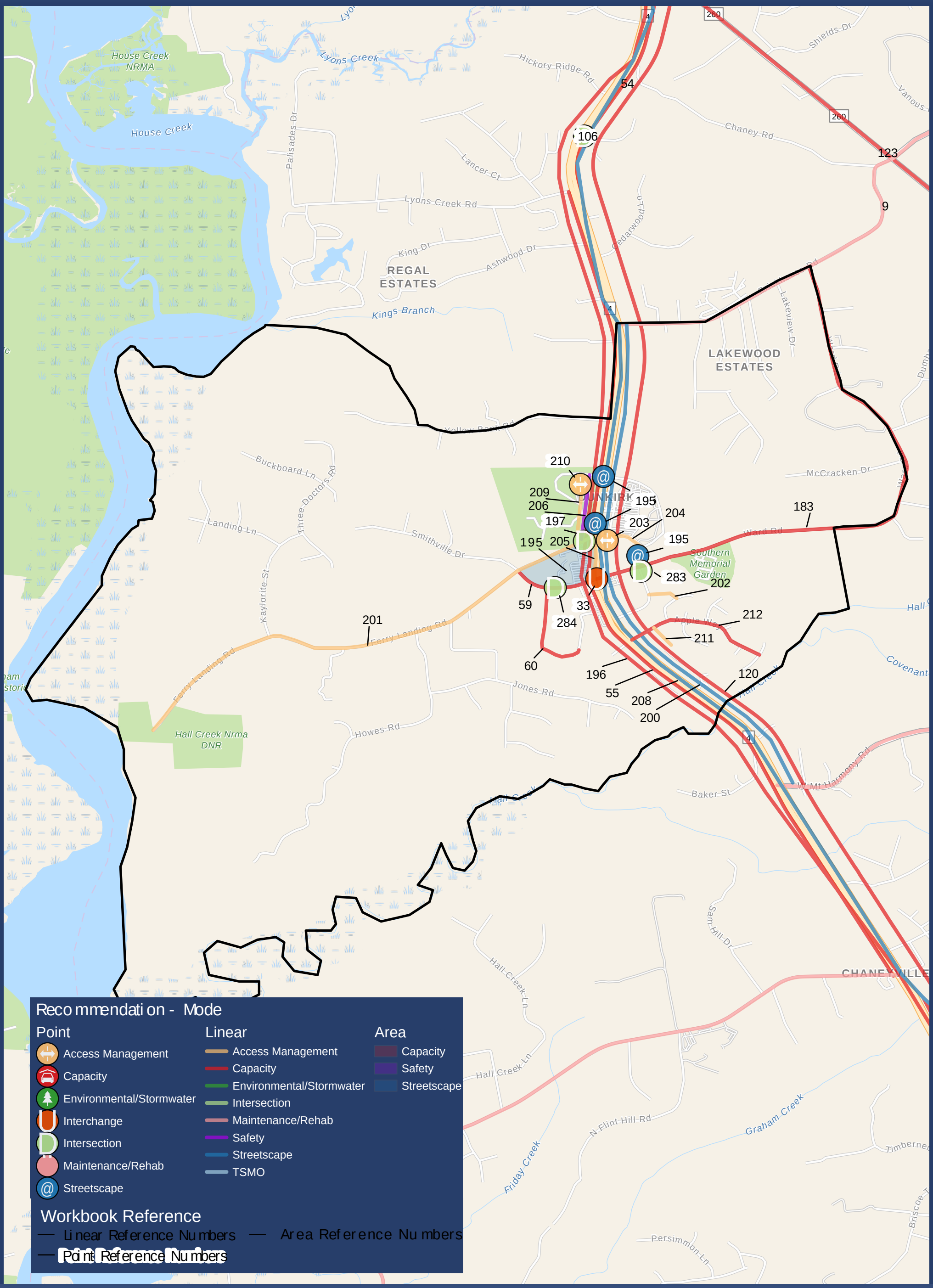
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Dunkirk - Roadway



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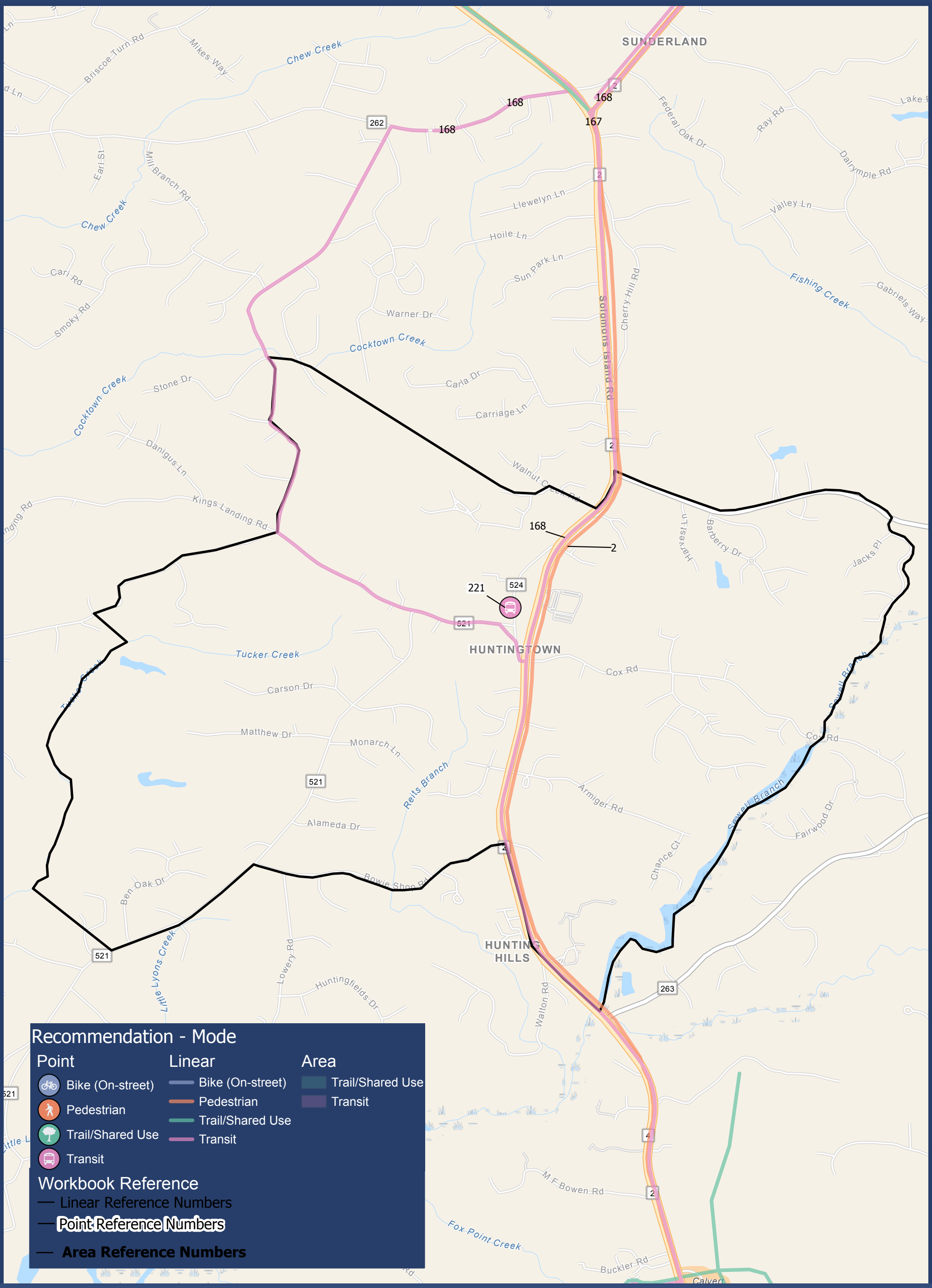
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Huntington - Ped/ Bike/ Trail/ Transit



Recommendation - Mode

Point	Linear	Area
Bike (On-street)	Bike (On-street)	Trail/Shared Use
Pedestrian	Pedestrian	Transit
Trail/Shared Use	Trail/Shared Use	
Transit	Transit	

Workbook Reference

- Linear Reference Numbers
- Point Reference Numbers
- **Area Reference Numbers**

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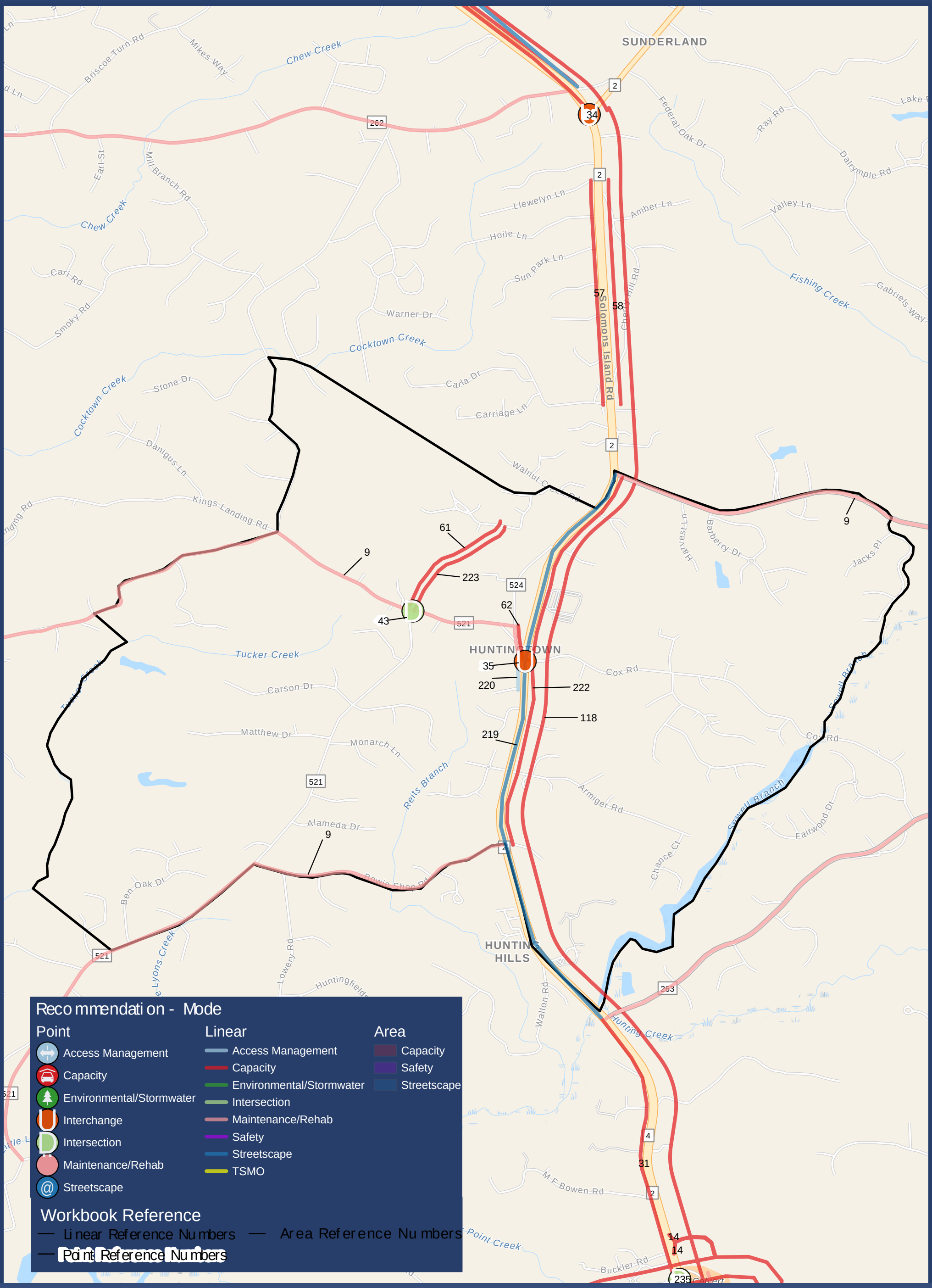
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Huntington - Roadway



Recommendation - Mode

Point	Linear	Area
Access Management	Access Management	Capacity
Capacity	Capacity	Safety
Environmental/Stormwater	Environmental/Stormwater	Streetscape
Interchange	Intersection	
Intersection	Maintenance/Rehab	
Maintenance/Rehab	Safety	
Streetscape	Streetscape	
	TSMO	

Workbook Reference

— Linear Reference Numbers — Area Reference Numbers

— Point Reference Numbers

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0 0.25 0.5 1 1.5 2 Miles

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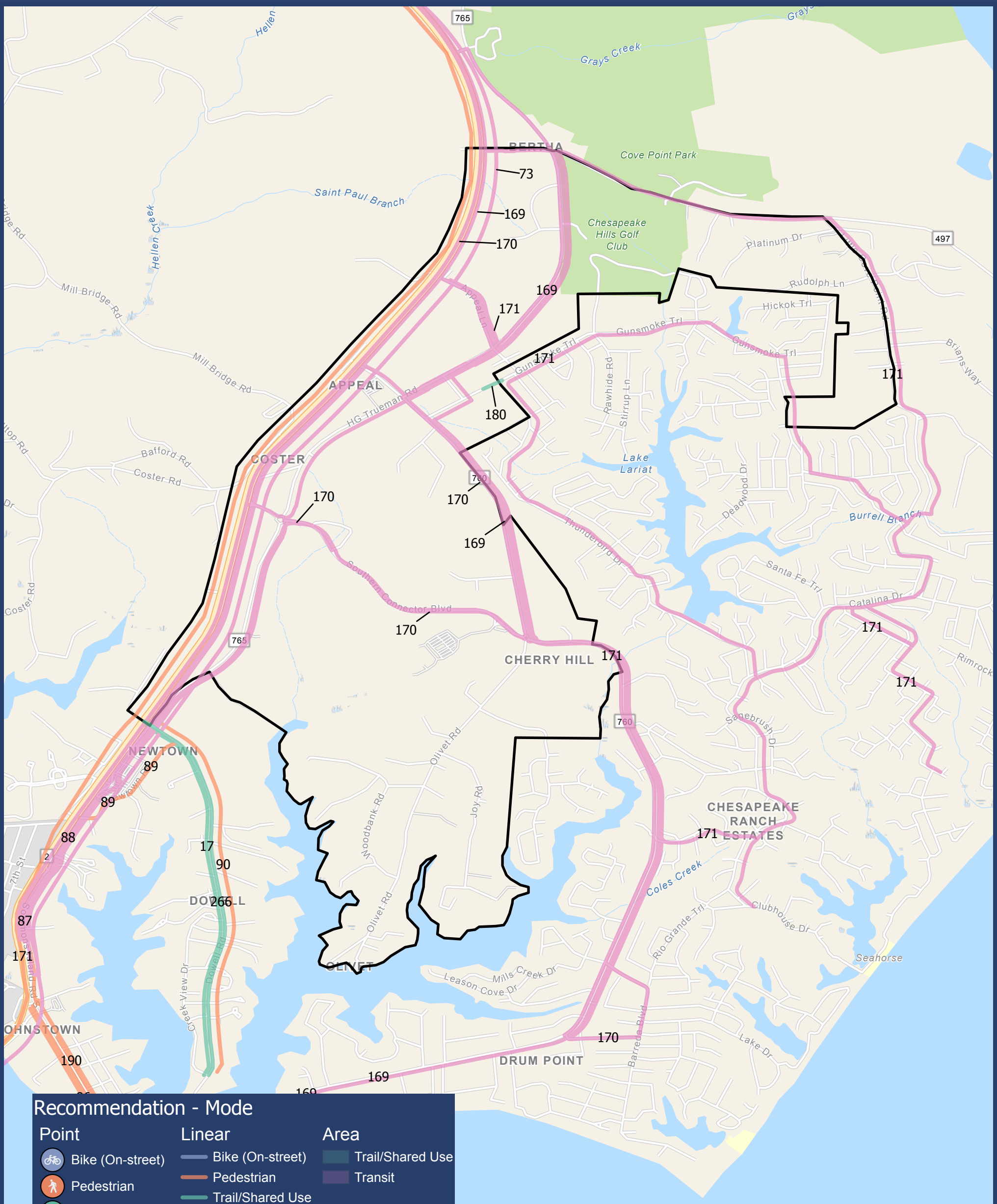
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Lusby - Ped/ Bike/ Trail/ Transit



Recommendation - Mode

Point	Linear	Area
Bike (On-street)	Bike (On-street)	Trail/Shared Use
Pedestrian	Pedestrian	Transit
Trail/Shared Use	Trail/Shared Use	
Transit	Transit	

Workbook Reference

- Linear Reference Numbers
- Point Reference Numbers
- **Area Reference Numbers**

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0 0.25 0.5 1 1.5 2 Miles

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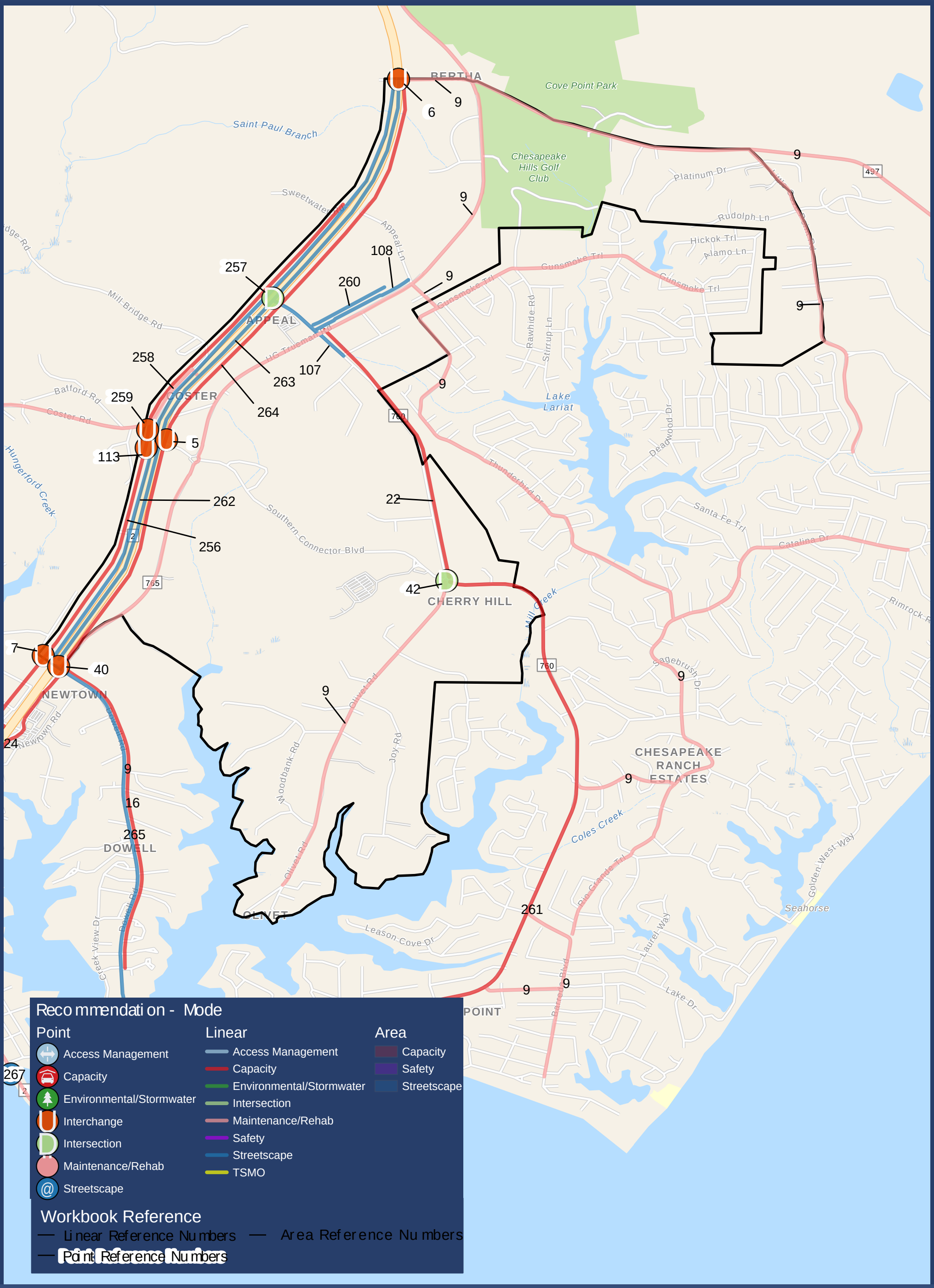
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Lusby - Roadway



Recommendation - Mode

Point	Linear	Area
Access Management	Access Management	Capacity
Capacity	Capacity	Safety
Environmental/Stormwater	Environmental/Stormwater	Streetscape
Interchange	Intersection	
Intersection	Maintenance/Rehab	
Maintenance/Rehab	Safety	
Streetscape	Streetscape	
	TSMO	

Workbook Reference

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0 0.25 0.5 1 1.5 2 Miles

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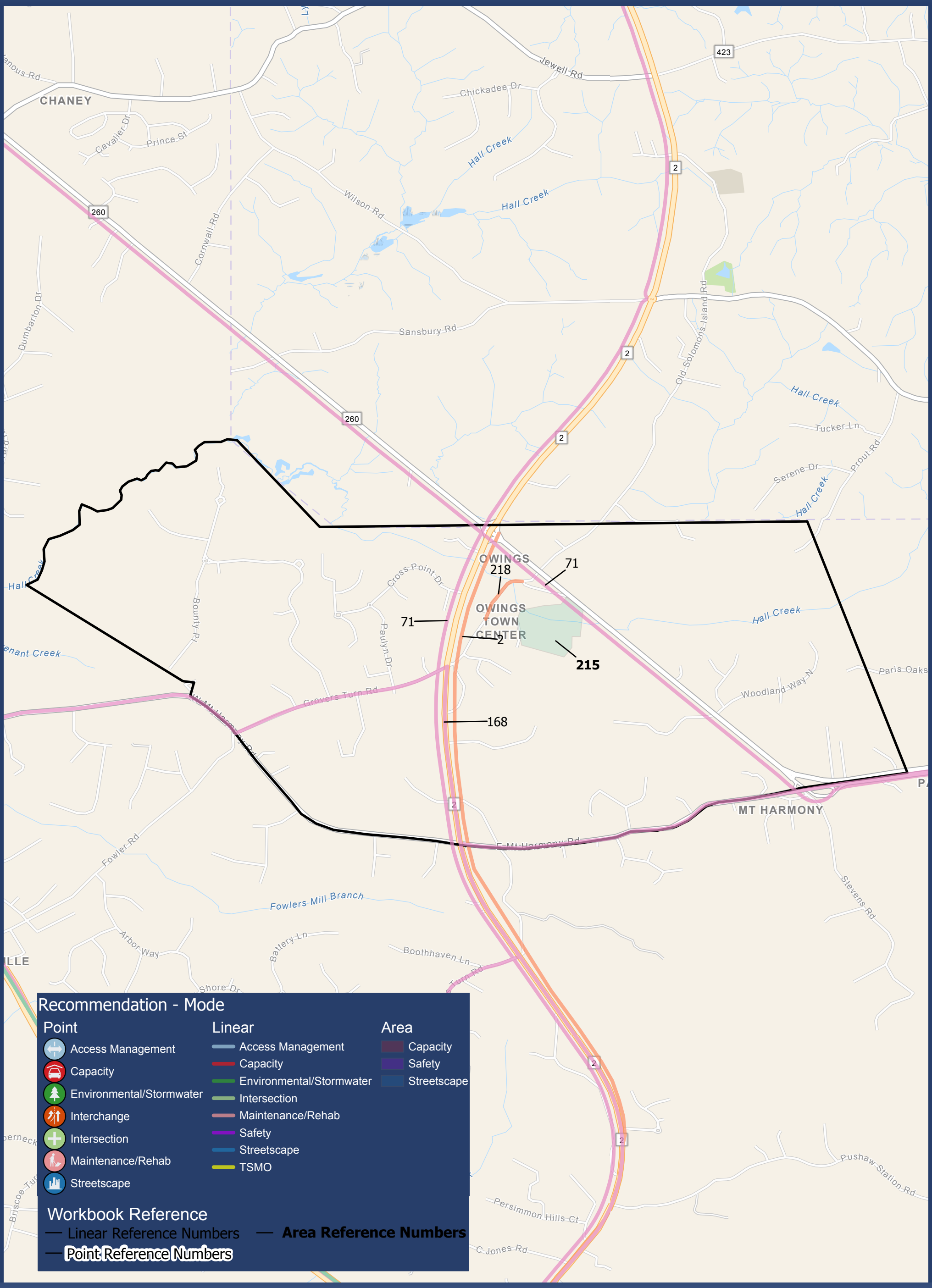
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Owings - Ped/ Bike/ Trail/ Transit



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0 0.25 0.5 1 1.5 2 Miles

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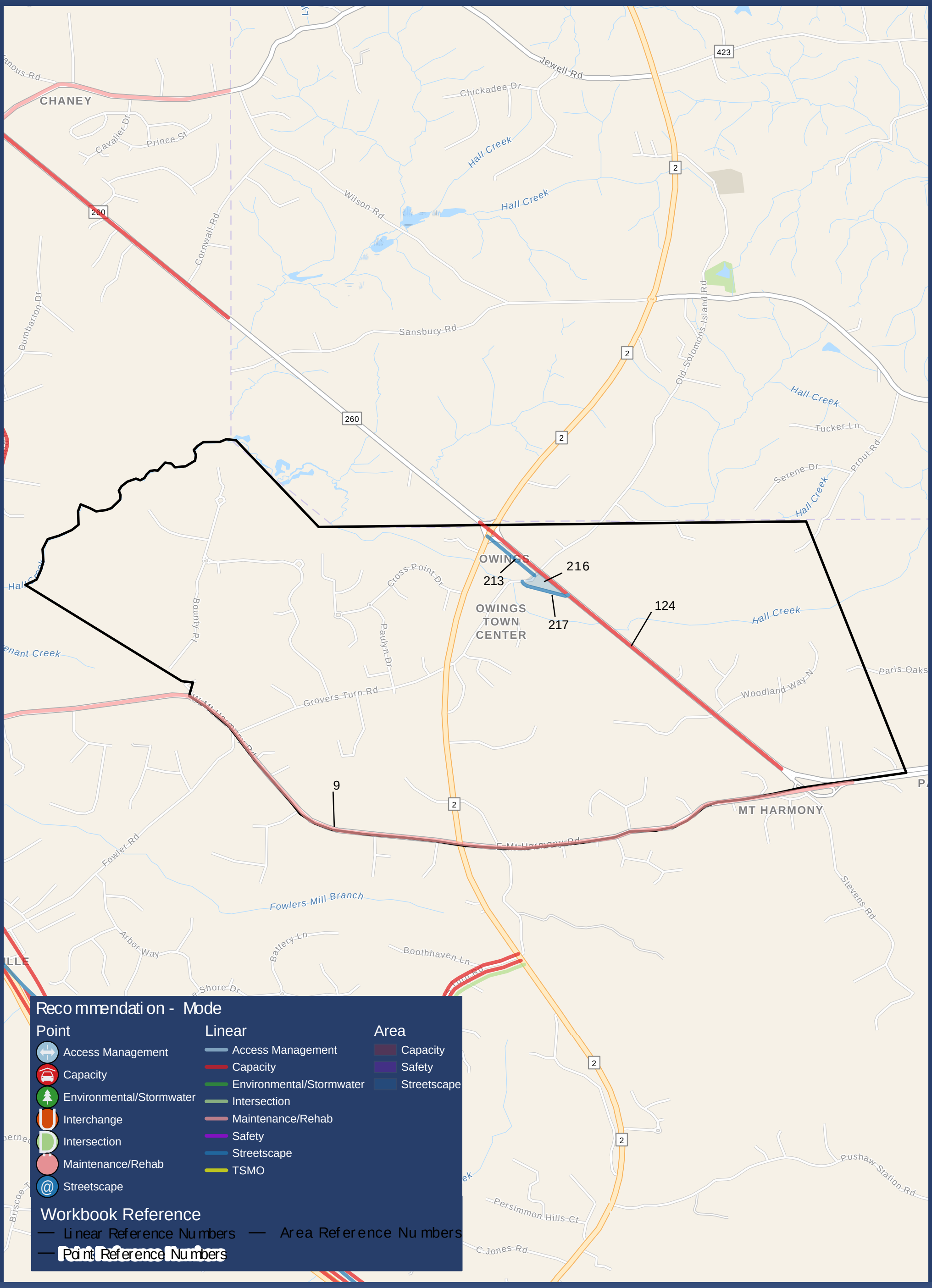
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Owings - Roadway



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0 0.25 0.5 1 1.5 2 Miles

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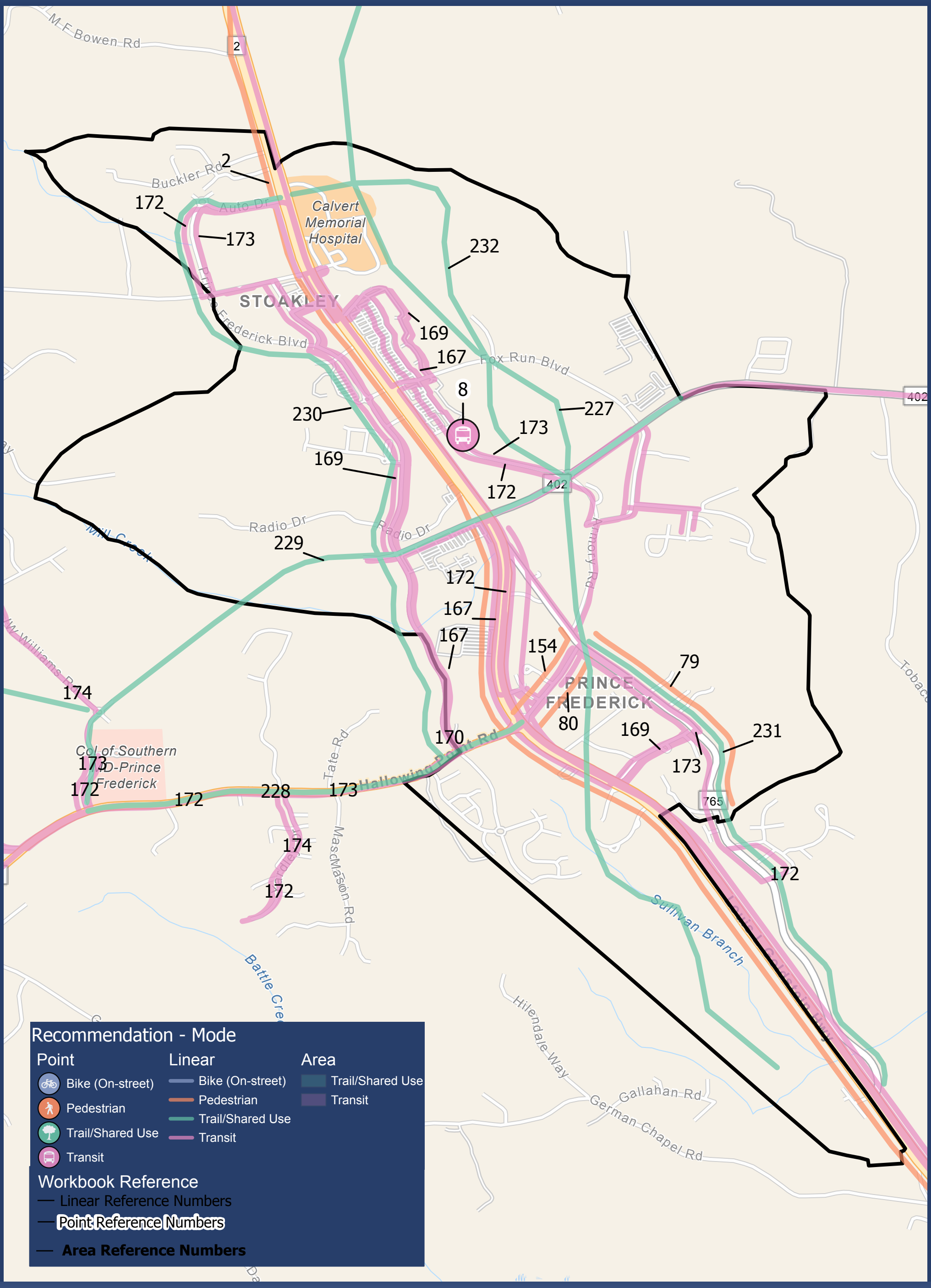
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Prince Frederick - Ped/ Bike/ Trail/ Transit



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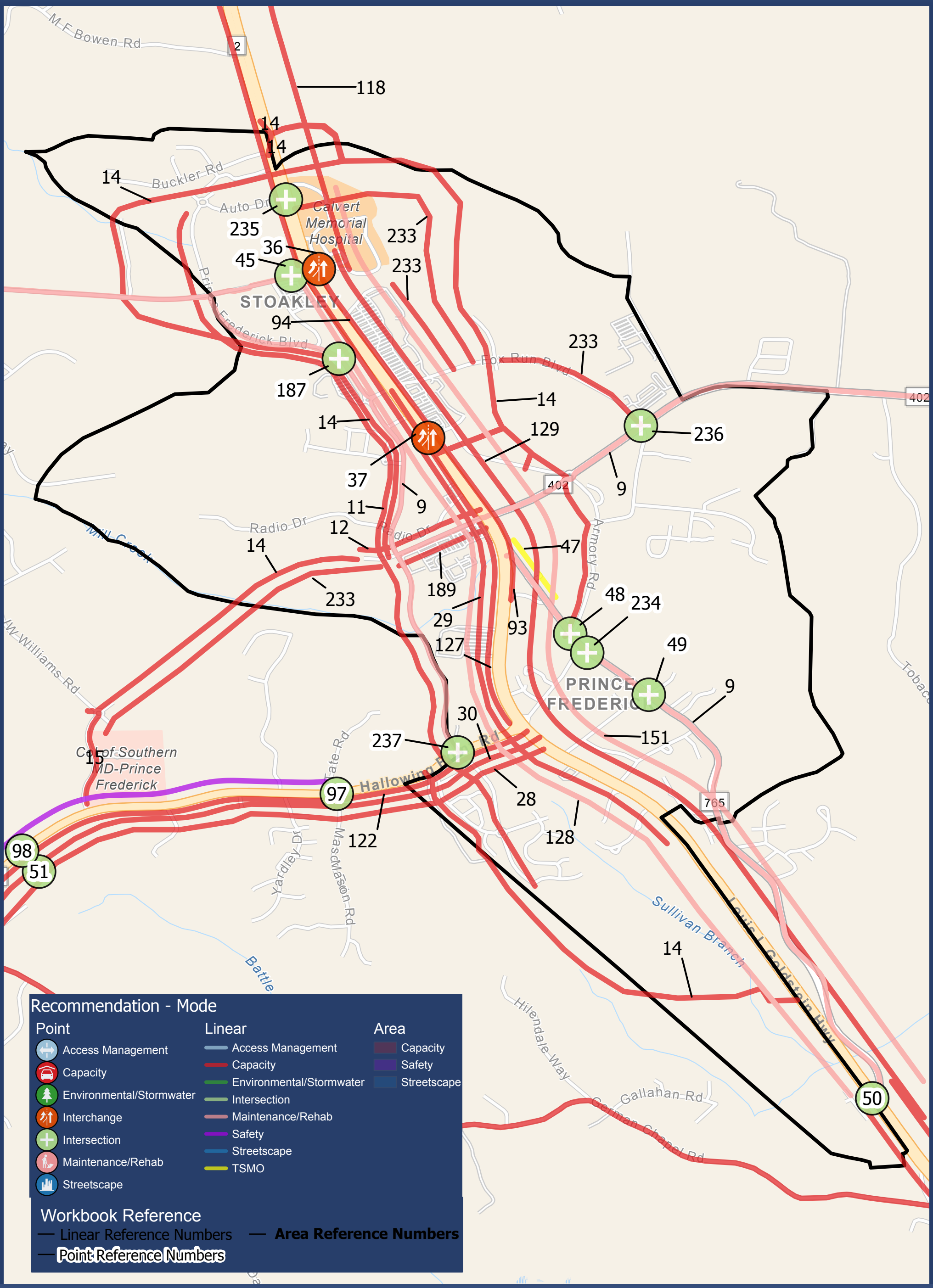
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Prince Frederick - Roadway



Recommendation - Mode

Point	Linear	Area
Access Management	Access Management	Capacity
Capacity	Capacity	Safety
Environmental/Stormwater	Environmental/Stormwater	Streetscape
Interchange	Intersection	
Intersection	Maintenance/Rehab	
Maintenance/Rehab	Safety	
Streetscape	Streetscape	
	TSMO	

Workbook Reference

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— Point Reference Numbers

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0 0.13 0.25 0.5 0.75 1 Miles

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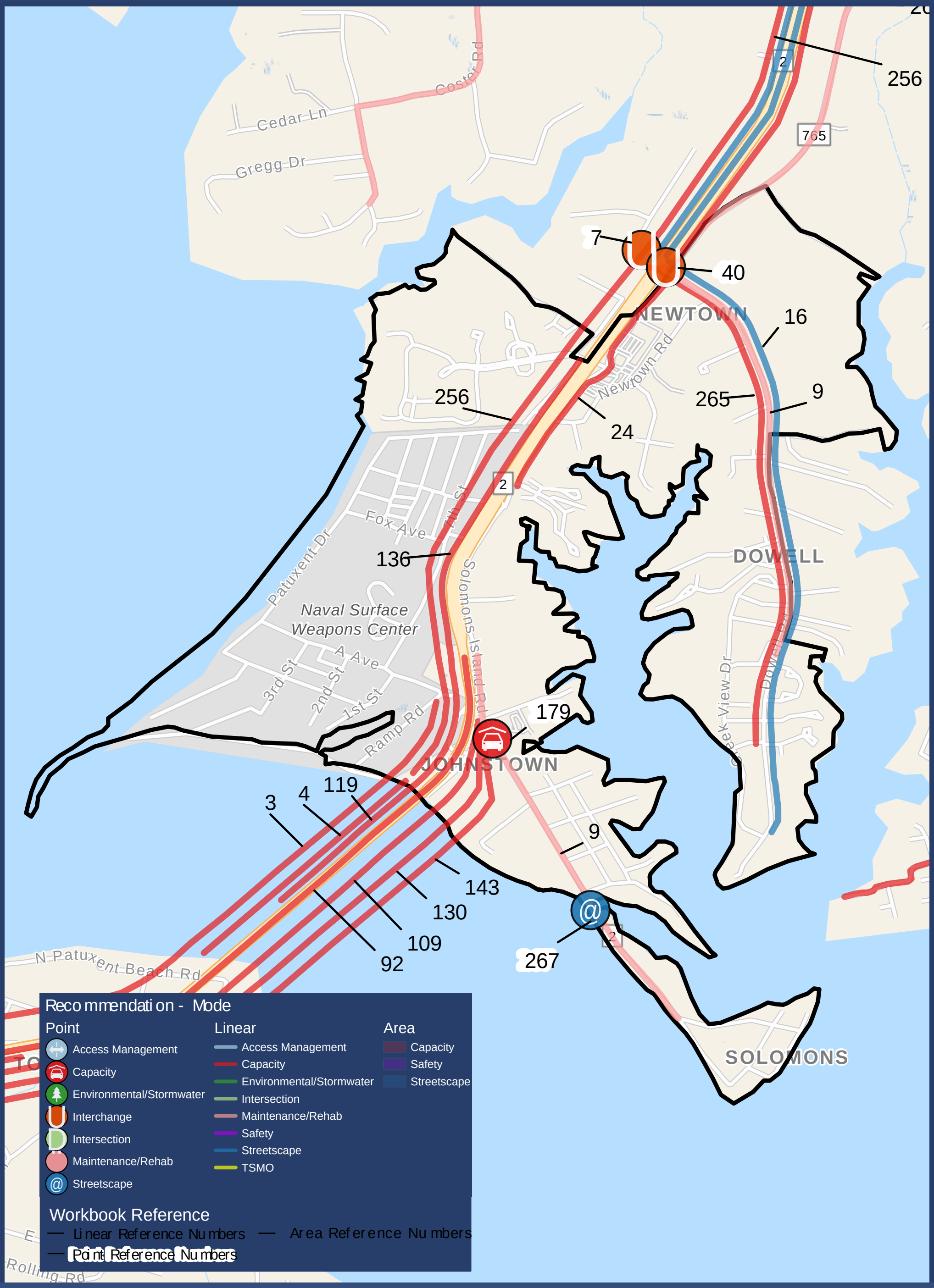
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

Solomons - Roadway



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0 0.13 0.25 0.5 0.75 1 Miles

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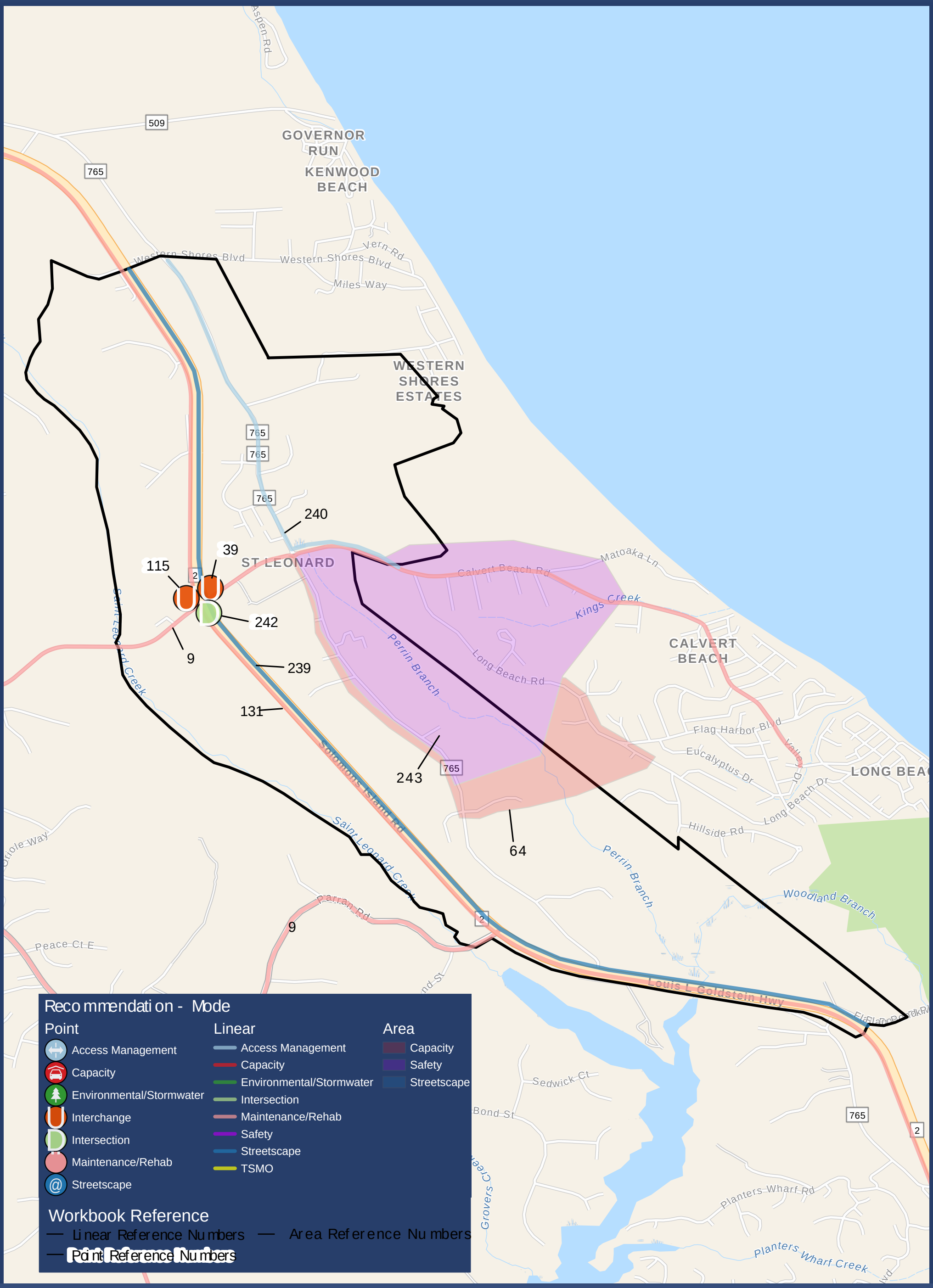
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

St Leonards - Roadway



Recommendation - Mode

Point	Linear	Area
Access Management	Access Management	Capacity
Capacity	Capacity	Safety
Environmental/Stormwater	Environmental/Stormwater	Streetscape
Interchange	Intersection	
Intersection	Maintenance/Rehab	
Maintenance/Rehab	Safety	
Streetscape	Streetscape	
	TSMO	

Workbook Reference

— Linear Reference Numbers — Area Reference Numbers

— Point Reference Numbers

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0 0.130.25 0.5 0.75 1 Miles

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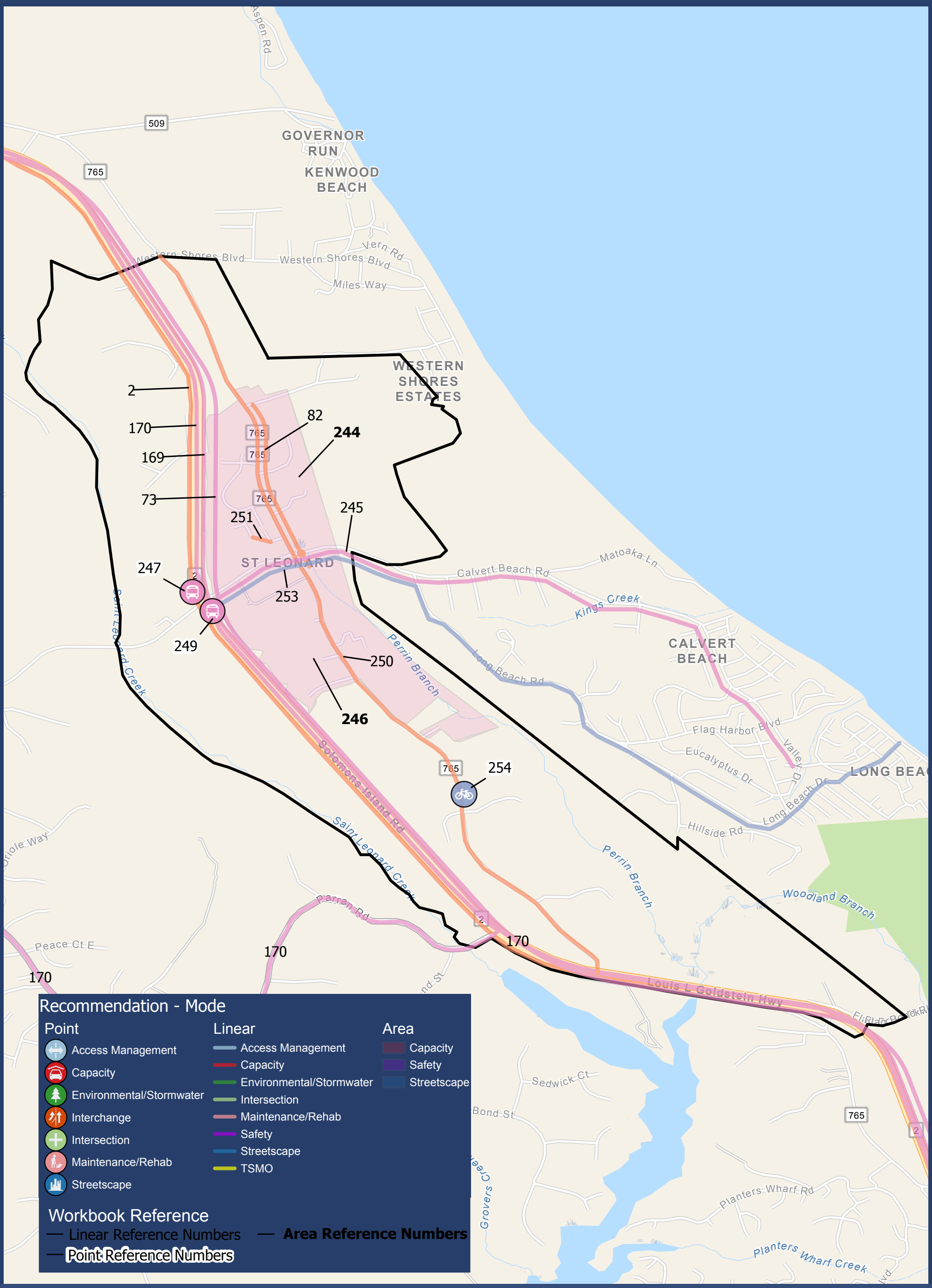
Calvert County Long Range Transportation Plan

Town Plans and Recommendations

St Leonards - Ped/ Bike/ Trail/ Transit



Recommendation - Mode

Point

- Access Management
- Capacity
- Environmental/Stormwater
- Interchange
- Intersection
- Maintenance/Rehab
- Streetscape

Linear

- Access Management
- Capacity
- Environmental/Stormwater
- Intersection
- Maintenance/Rehab
- Safety
- Streetscape
- TSMO

Area

- Capacity
- Safety
- Streetscape

Workbook Reference

— Linear Reference Numbers — **Area Reference Numbers**

— Point Reference Numbers

SABRA & ASSOCIATES
Engineering Innovative Solutions

0 0.130.25 0.5 0.75 1 Miles

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CALVERT COUNTY TRANSPORTATION PLAN

TECHNICAL MEMORANDUM #2

Assessing Smart Transportation Technologies and Opportunities for Calvert County

March 2019

SABRA & ASSOCIATES
Engineering Innovative Solutions

Note: This is the second in a series of technical memoranda prepared for the Calvert County Department of Planning & Zoning in developing the Calvert County Transportation Plan. The purpose of each technical memorandum prepared for is to present facts, analysis, ideas, issues and recommendations that will inform the plan. The views expressed, and recommendations offered in each memorandum are solely based on the consultant's judgment and should not be considered as endorsed by the Calvert County Department of Planning & Zoning or any other county department or officer.

This memorandum was prepared by Kimley-Horn and Associates, a subconsultant to Sabra and Associates.

Contents

Introduction

As part of developing Calvert 2040, the Calvert County Comprehensive Plan, the Department of Planning & Zoning has initiated an update of the county's transportation plan which was initially written in 1997. The purpose of the transportation plan is to guide the county's future investments in and advocacy for the County's multimodal transportation network. This memorandum surveys the current state of the art in transportation technology, summarize the state of transportation technology in Maryland and surrounding areas, and offers potential strategic goals and opportunities for the future of transportation in Calvert County.

This memorandum focuses on opportunities along MD 2/4 which is the county's transportation spine. While MD 2/4 is owned and operated by the MDOT State Highway Administration, the county can play an important advocacy role to encourage greater use of technology to address traffic congestion and safety. Maintaining a steady and safe flow of traffic (people and goods) through the town centers is critical the county's economic future and quality of life for all residents. Technology solutions may be leveraged to accommodate an increase of trips in the existing transportation network with minimal additional infrastructure; this approach advances the county's goals with respect to environmental protection.

Technology has been long-embraced at the state and local levels in Maryland, although certain corridors have been of greater focus than others. Numerous plans and programs have been established which embrace the approach that technology is one of the strongest tools to manage and mitigate growing traffic congestion. Beyond just roadways and traffic signals, a smart and technology-enabled transportation system requires a network of infrastructure including data collection equipment, communications equipment, data storage, monitoring systems, and dedicated maintenance staff. Together, these assets provide information that can aid in decision making and serve as tools to better manage traffic congestion when it occurs.

Current State of Smart Technology in the Transportation Industry

The transportation industry is currently undergoing a revolution with the integration of technology solutions that address key challenges to safety, mobility, and the environment. Many agencies are finding that there is no longer space to simply increase the capacity of roadways. As a result, technology is being leveraged to move people more efficiently within the available infrastructure. Additionally, the face of transportation is shifting dramatically with the proliferation of connected vehicle (CV) technology, automated vehicles (AV), and shared mobility solutions. While the industry is years away from leveraging this sector of transportation technology to its fullest, laying groundwork now will aid the seamless integration for whatever the future may hold. This section describes the state of the art in intelligent transportation systems (ITS), then describes the existing state and future potential for CV/AV (referred to herein as CAV).

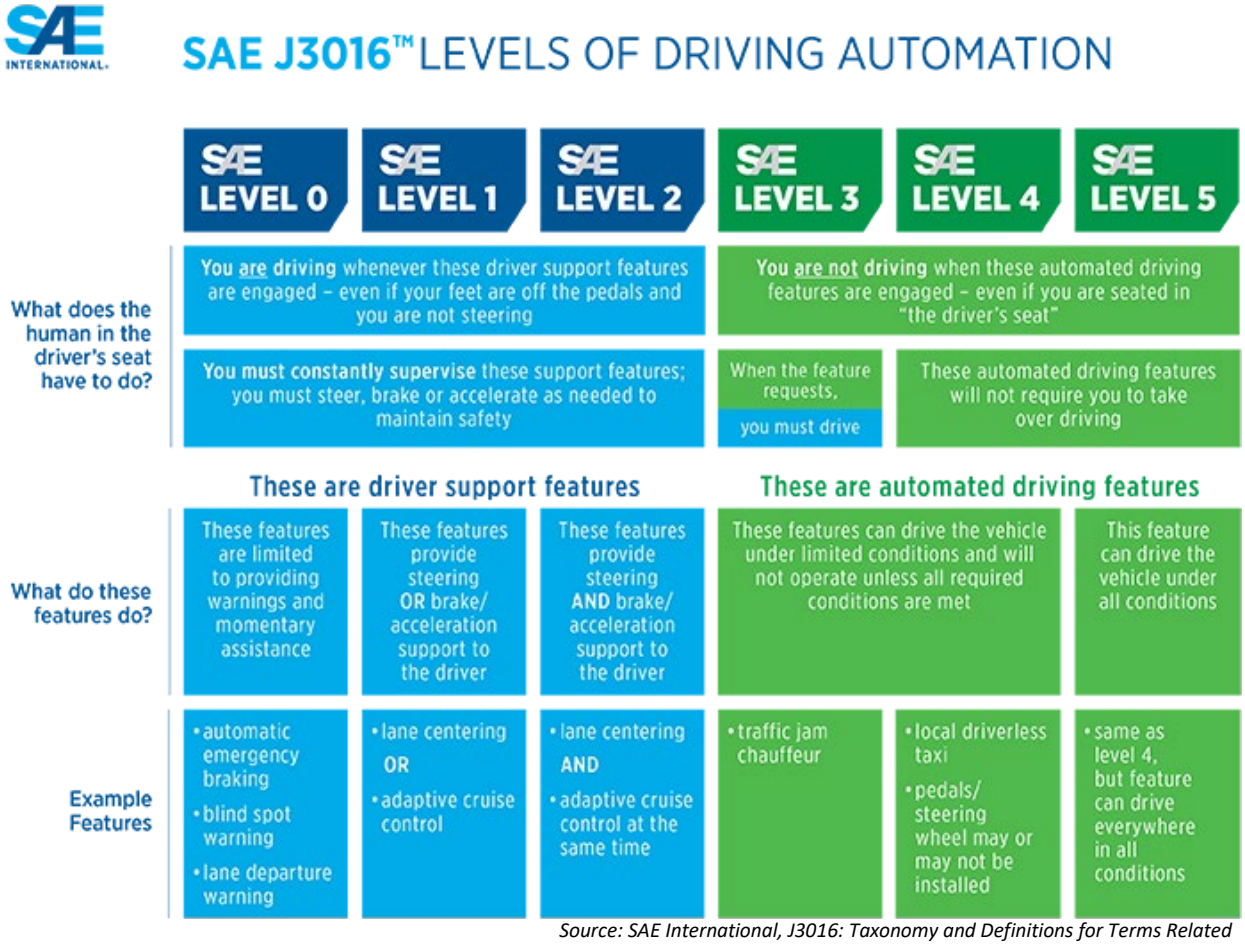
Intelligent Transportation Systems

The US Department of Transportation (USDOT) defines Intelligent Transportation Systems (ITS) as the integration of advanced communications technologies into the transportation infrastructure and in vehicles to enhance safety, mobility, and productivity[1]. ITS encompass a broad range of wireless and wire line communications-based information and electronic technologies. Examples of commonplace ITS applications include active traffic management, traffic data gathering/dissemination, traffic data management, and general data governance.

Connected and Automated Vehicles

Related to ITS is the emerging industry of Connected and Automated Vehicles (CAV). Automation is the use of electronic or mechanical devices to operate one or more functions of a vehicle without direct human input (USDOT). The six widely-accepted levels of driving automation, developed by the Society of Automotive Engineers (SAE), are described below.

[1] United States Department of Transportation, Intelligent Transportation Systems Joint Program Office



Source: SAE International, J3016: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles, www.sae.org.

While levels of vehicle automation vary greatly, most technologies rely on some degree of digital communication and data exchange. Exchanges may happen between vehicles (vehicle to vehicle, or V2V), between a vehicle and surrounding wayside devices (vehicle to infrastructure, or V2I), or generally between any combination of vehicles and another transmitter/receiver (V2X). This data is useful at many levels of transportation infrastructure, from the control of a single vehicle to the management of an arterial corridor. In the future, this may mean vehicles relaying their positions to one another, transferring vehicle speeds to agency-managed traffic control centers, or identifying potential hazards within the vehicle's travel path. In the current state, much of the CAV technology relies on visual aids, including lane lines and highway signs. For example, a lane deviation warning and correction system must recognize pavement marking in order to determine if the vehicle's position is correct. Thus, prioritizing pavement marking and sign maintenance as well as ensuring clear lines of sight along roadways, are priorities that benefit both the current network and potential CAV integration.

Automation and connectivity has and will continue to have a growing role in the transportation industry. Paramount in this role is the ability for CAV to improve safety of transportation network users, followed by the management of congestion and potential increased capacity of existing infrastructure in the future. However, with the technology still evolving and with limited understanding of what the future

will look like, it is a challenge to assess the impact of CAV technology at this time. Research regarding CAV integration into existing infrastructure is ongoing, and it will continue to change the outlook of the industry.

Shared Mobility

Shared mobility is a growing trend in the transportation industry that describes the transition from single-occupancy, private vehicles to transportation resources and services that are shared among users, either concurrently or one after another (*Shared Use Mobility Center*). Technology has served to revolutionize this concept with mobile applications, data sharing, and communications innovations. Examples of shared mobility include car or bike sharing (such as Zipcar or Capitol Bikeshare), ridesharing (such as Via), Ridehailing or Ridesourcing (such as Uber or Lyft), public transit, or other kinds of transit shuttles.

State of Smart Transportation Technology in Maryland and Surrounding Areas

The state of Maryland is home to many transportation challenges including busy arterial corridors, dense urban cities, and aging critical infrastructure. In order to best manage the state's transportation resources and respond to these challenges, several programs and plans have been established concerning the future of transportation and technology in the state. These efforts are led by the Maryland Department of Transportation (MDOT) and its various business units, including Maryland State Highway Administration (SHA). This section will describe some of these programs and initiatives, including traffic control centers, a statewide congestion management plan, a statewide CAV strategic plan and working group.

Maryland Coordinated Highways Action Response Team

To improve traffic flow around the state, Maryland created the Coordinated Highways Action Response Team (CHART) as one its first ITS initiatives. The primary function of CHART is to maintain the safe and efficient flow of traffic throughout Maryland through the coordination of the Statewide Operations Center (SOC) and surrounding operations centers to monitor and adapt to changing conditions on Maryland Roadways. CHART coordinates a network of field technicians who patrol Maryland's principal arterials to assist in clearing incidents (crashes, debris, severe weather, etc.) and assisting approximately stranded motorists on Maryland roadways. CHART field technicians do not patrol MD 2/4 in Calvert County.

Source: Maryland CHART Traffic Operations Center, https://chart.maryland.gov/about/overview.asp

Smart Signals Program

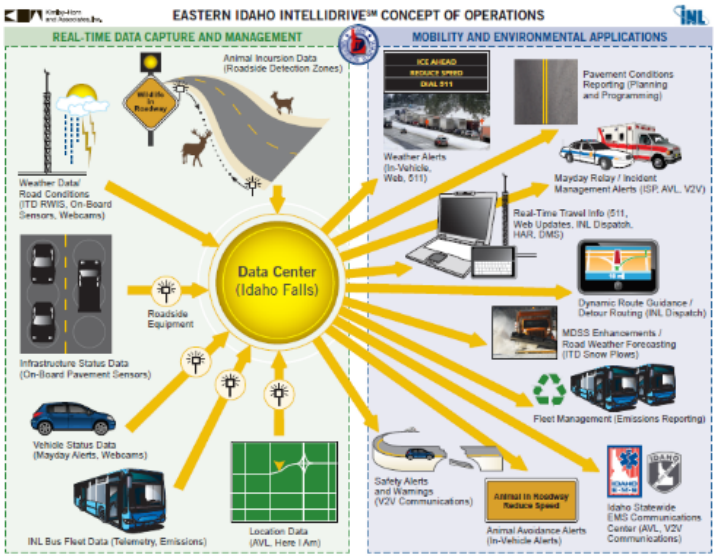
Maryland is executing a multi-phase traffic relief plan that involves a combination of geometric roadway capacity increases and installation of a 'Smart Signal System' on critical corridors throughout the state. These systems use real-time data to dynamically adapt signals to variable traffic demand. Using these systems, roadways that require additional vehicular capacity will receive more time when they need it for throughput, effectively reducing delay experienced system-wide. Neither MD 2 nor MD 4 in Calvert County is included in the Smart Signals program.

Maryland CAV Strategic Plan

MDOT SHA and the Motor Vehicle Administration (MVA) have identified CAVs as a key opportunity to improve traffic operations and safety – as well as the need to prepare Maryland's physical, social and legal infrastructure to accommodate the requirements of CAVs. MDOT's CAV vision is to "Embrace technology and next generation mobility trends to provide safe and reliable travel for people and goods within Maryland." This vision is supported with five goals, as summarized below:

1. Make Maryland an attractive partner for CAV development, testing, and production.
2. Begin deploying CAV technology and engaging in national activities.
3. Establish foundational systems to support future CAV deployment.
4. Enable CAV benefits for MDOT SHA customers.
5. Look for opportunities to leverage CAV technologies to support MDOT SHA business processes and objectives.

The execution of work to achieve these goals has already begun with the identification of key Maryland travel corridors as testing grounds for CAV technology. MDOT is pursuing expanded funding to continue to improve US Route 1 and I-95 in central Maryland by using advanced technology infrastructure deployments in these corridors. MVA is working with automotive automation organizations to identify strategic locations for testing; and is leading the development of new laws and regulations for the deployment of CAVs.



Source: Kimley-Horn and Associates, Tailored Connected Vehicle ConOps for rural issues, 2012

Source: Maryland DOT.

Smart Transportation Technologies used in and near Calvert County

The SHA has implemented several technologies in the areas surrounding Calvert County but has only limited deployments within the county. Currently, MD SHA maintains three video monitoring cameras: MD 260 at Cox Road in Chesapeake Beach, and two at the major bridge crossings of the Patuxent River (MD 4 and MD 231). Further north, MDOT has implemented the Smart Signals on MD 2 approaching Annapolis and dynamic message signs and traffic monitoring cameras along MD 301 through Anne Arundel and Prince George's Counties.

One limitation on MDOT SHA's ability to deploy transportation technology solutions in Calvert County is the limited communications infrastructure such as fiber optic lines which enhance the ability to implement additional video cameras, gather real-time data, operate dynamic message signs and implement real-time traffic signal control. These limitations will become more apparent as the number of connected vehicles using communications devices to convey and share information grows as CAV technology improves and expands. Calvert 2040, Calvert County's comprehensive plan, calls for the continued development of a broadband network for use in a variety of applications. This network could include greater communications capabilities with transportation technology. The plan prioritizes the provision of broadband in Town Centers and villages; as such, this makes these locations candidates for small scale transportation technology pilot projects.

Lastly, the automotive market is continuing to evolve to include electric vehicles (EV) as technology advances. Urbanized areas house most of the EV charging stations, making the use of electric vehicles in rural areas challenging because of the range of vehicles before they need to be charged.

MDOT, through its Electric Vehicle Infrastructure Council (EVIC), has identified electrification opportunities across the state and will continue to determine the needs and opportunities for electrified vehicles in the future.

Opportunities and Recommendations for Calvert County

The Calvert County Transportation Master Plan is an opportunity to increase the emphasis on transportation technologies to mitigate the growth in traffic congestion rather than building new travel lanes. Further, to mitigate the effect of events such as severe weather, traffic crashes, and delays in upstream traffic, increasing the use transportation technologies is an opportunity to improve public safety. Achieving these aims requires that Calvert County prioritize transportation technology improvements in making annual funding requests to MDOT.

As a first step, the County should request that MDOT SHA assess its communications infrastructure and develop a transportation technology plan specifically for MD 2/4. Specific improvements should include:

- Install CCTV coverage at key bottleneck locations.
- Deploy dynamic message signs (DMS) at decision points along MD 2/4 such as approaching MD 231 and MD 506 to direct traffic to the MD 231 bridge to avoid traffic incidents ahead

and approaching the MD 2/4 split when there is an incident further upstream near MD 301 and I-95.

- Inclusion of MD 2/4 through Prince Frederick and through Lusby/Solomons in the Smart Signals program

Emerging technologies can be applied to improve traffic safety with a specific opportunity for high-speed signalized rural intersections. Dilemma Zone Protection (DZP) is a technology-focused solution that modifies traffic signal timings based on the approach and speed of vehicles approaching the intersection, thus reducing or eliminating a potential dilemma zone where a driver may be unable to make a safe maneuvering decision. Dilemma Zone Protection is relevant to Calvert County's rural highways such as MD 2/4 and has the potential to reduce side-angle crashes caused by red-light running and rear-end collisions often caused by distracted driving.[2] Two pilot locations were studied by MDOT SHA and the University of Maryland with mixed results. As the technology improves, the County should encourage MDOT SHA to deploy Dilemma Zone Protection at key locations along MD 2/4.

[2] Maryland DOT-SHA Final Research Report, *Intelligent Dilemma Zone Protection System at High-Speed Intersections*, Park and Chang, Department of Civil and Environmental Engineering, University of Maryland, July 2017.

CALVERT COUNTY TRANSPORTATION PLAN

TECHNICAL MEMORANDUM #3
Summary of Existing Conditions

April 2019

SABRA & ASSOCIATES
Engineering Innovative Solutions

Note: This is the second in a series of technical memoranda prepared for the Calvert County Department of Planning & Zoning in developing the Calvert County Transportation Plan. The purpose of each technical memorandum prepared for is to present facts, analysis, ideas, issues and recommendations that will inform the plan. The views expressed, and recommendations offered in each memorandum are solely based on the consultant's judgment and should not be considered as endorsed by the Calvert County Department of Planning & Zoning or any other county department or officer.

Contents

Introduction

Calvert County is a long narrow peninsula bounded by the Potomac River to the west and the Chesapeake Bay to the east and south. One bridge crosses the Potomac River to the west approximately two-thirds of the way south of the northern county boundary; the Thomas Johnson Bridge crosses the Potomac River to the south into St. Mary's County. Prince George's and Anne Arundel Counties abut the northern boundary to the northwest and northeast, respectively. The County's geography dictates the transportation network with MD 2/4 acting as a spine and several state roadways stemming east and west supported by a local network of collectors and minor arterials connecting further to the interior.

Over a thirty-year period beginning in the mid-1980s, Calvert County's population grew by nearly 170% to 97,500 residents. This growth can be attributed to the always strong federal sector in the core of Washington, DC and at Joint Base Andrews, Suitland and New Carrollton among other suburbs, and base realignment to the benefit of Patuxent River Naval Air Station. Newcomers were willing to exchange a longer commute for Calvert County's high quality of life with easy access to the Chesapeake Bay and Patuxent River, low taxes and good schools.

During that time, MDOT's State Highway Administration widened portions of MD 2/4 and worked closely with the County on access management strategies to mitigate some of the stop-and-go traffic. MDOT's Maryland Transit Administration grew its commuter bus ridership and park-and-ride capacity nearly ten-fold. The County also implemented a growth management strategy that preserved rural areas and targeted town centers in Solomons/Lusby, Prince Frederick, Dunkirk and elsewhere for residential and commercial development.

Thirty years after the residential boom started, population growth has stabilized. Projections through 2040 indicate a rate of growth in Calvert County averaging 0.5% annually.[1] While Calvert County's population growth has stabilized, its demographics and commuting patterns are changing rapidly. Baby boom retirements have reduced the number of persons in the workforce, but those who are working are do so with a longer commute to a destination outside of the County.

Key Transportation Characteristics	2009	2016
Workers 16 Years or Older	45431	44872
Drive Alone	90.2%	90.1%
Use Public Transit	3%	3%
No Vehicle in Household	1.0%	1.5%
Work in County of residence	41.1%	38.1%
Average time to work (minutes)	39.3	41.4
Greater than 60 min drive	26.4%	29.0%

Table 1 Transportation Characteristics in Calvert County
Source: American Community Survey

Throughout the building boom, the County was developed in a typical auto-oriented suburban fashion with agricultural, commercial, residential and industrial areas generally separated through zoning practices. Beginning with the ____ comp plan, the county developed a strategy that concentrated growth within town centers as the focal point of residential and commercial development. Still, the predominant mode of transportation in Calvert County is the personal auto. More than 90% of county residents commute to work alone in their personal vehicle; less than 3% percent use public transit. Given the

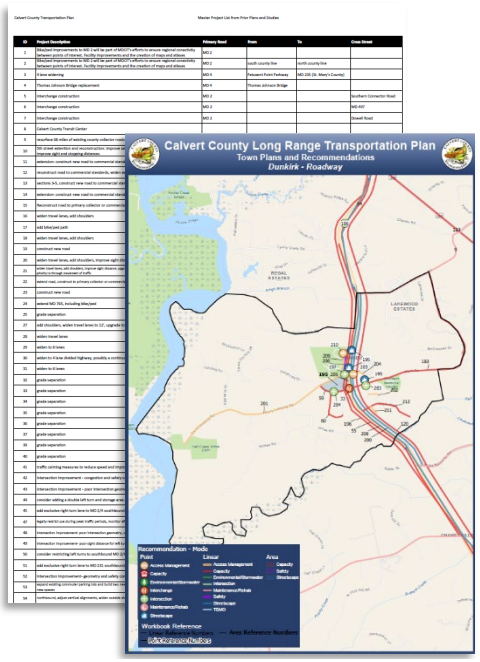
[1] Moving Forward 2040: C-SMMPO Long Range Transportation Plan, Chapter 2.1

development pattern and the distance from major employment centers, there is no evidence that at a countywide scale these modal shares are likely to change; however, it is possible that development policies and transportation investments can shape the town centers with a balanced transportation network in certain corridors and smaller planning areas. The transportation focus of the town center planning is to provide a local road network that keeps trips circulating without needing to use MD 2/4, and to create a pedestrian friendly environment that reduces the need for short-distance auto trips.

This report documents existing demographic, land use and transportation conditions in the county which will be used in support of a countywide transportation master plan. The TMP will act as a bridge between the proposed comprehensive plan and the small area plans for each of the town centers which will implement the comprehensive plan's land use and growth elements. This report also documents how the transportation system is owned and operated and the sources and uses of funds to maintain and expand the multimodal transportation network.

Previous Studies

In preparing the TMP, approximately twenty studies and plans developed since 1999 were reviewed to identify specific transportation improvements and policies proposed within the county. A comprehensive listing of transportation plans and projects identified by local, regional and state agencies for potential implementation in Calvert County was developed. The recommendations of these plans total 284 projects relating to access management, new road capacity, stormwater and drainage, intersection improvements, road maintenance, safety, streetscape, local transit service and transportation systems management and operations strategies. 284 transportation projects ranging from new interchanges along MD 2/4 to sidewalks in each of the town centers; recommendations also include Technical Memorandum #1 provides a summary of all reviewed plans and recommendations.



Partial list and map of transportation projects.

Reviewed plans included transportation planning and policy statutes, transportation planning and budget documents, town center master plans and budgeted improvements. Reviewed documents identified project and policy recommendations.

Roles and Responsibilities

A number of agencies and organizations are responsible for constructing and maintaining roads and bridges, developing and operating transit networks and expanding the bicycle and pedestrian network. The traveling public makes little distinction between these agencies. What matters is that the traveler can drive, ride or walk to their destination in a manner that is safe and reliable. Each of the below described agencies focus on the transportation issues in a different capacity.

Calvert County Department of Public Works

The Calvert County Department of Public Works (DPW) has responsibilities ranging from managing the fleet of government vehicles, water/sewer, solid waste to engineering, construction and maintenance of county owned roads and bridges.

The Highway Maintenance Division oversees the maintenance of more than 900 lane miles of county's road network including drainage improvement, roadside shoulders, guardrails and road signage. This division is responsible for conducting roadway line striping, cutting back roadside landscaping, repairing potholes and litter pick up, in addition to response to all emergency and weather-related situations. The Engineering/Transportation Division develops, coordinates, issues, evaluates and monitors proposals and contracts for highway maintenance and capital projects. The division also reviews residential, institutional and commercial plans for subdivisions, reviews building and grading permits, administers public works agreements including the collection and monitoring of bonds, coordinates road development and storm water management/grading inspections with the Division of Project Management. The department also supervises all road and bridge construction and maintenance projects.

The Division of Project Management and Inspection reviews and approves all grading and utility permit applications for single-family dwellings and institutional, commercial and industrial sites including utility cuts within the county rights of way. The division is also responsible for enforcement of sediment control for single-family lots and inspection of all stormwater management facilities, construction of subdivision streets and all county road-related contracts.

State Highway Administration

The Maryland State Highway Administration (MDOT SHA) is responsible for constructing, operating and maintaining approximately 126 miles of state-owned roadways in Calvert County such as MD 2/4, MD 261 and MD 765 and other numbered roadways. MDOT SHA roads tend to operate at speeds greater than 35 miles per hour and carry traffic through the county and connecting town centers and municipalities. MDOT SHA owns 42 signals in Calvert County. MDOT SHA also maintains two bridges in Calvert County, the MD 261 Benedict Bridge and the MD 4 Thomas Johnson Bridge.

Municipal Agencies and Private Organizations

The towns of North Beach and Chesapeake Beach are responsible for the construction and maintenance of approximately 49.7 lane miles collectively. In addition, homeowners' associations such as those at Chesapeake Ranch Estates and White Sands are responsible for the maintenance of roads within their boundaries.

Calvert County-St Mary's MPO

(C-SMMPO) performs regional transportation planning as required by federal law in a continuing, cooperative, and comprehensive process that involves identifying improvements to facilities and operations. The goal of this process is to provide a well-maintained, multimodal

transportation system that allows for the safe, convenient, affordable, and efficient movement of people, goods, and services. C-SMMPO assists with transportation decision-making, planning and programming amongst federal, state, and local government. The C-SMMPO Council, which comprises one commissioner from Calvert County, one commissioner from St. Mary's County, and one representative from MDOT.

County Roads and Bridges

The core transportation responsibility of any local government is to maintain its assets in a state of good repair. The county owns 541 miles of roadway (approximately 1842 lane miles) of which DPW estimates that 50% is in good condition while the balance is evenly split between fair and poor condition. DPW is currently undertaking a formal roadway condition assessment to inform its annual paving program.

There are two areas of special concern for the county's roads. The implication of these concerns will be addressed in the Transportation Master Plan:

- Fifteen roads carry a historic designation
- More than thirty roads have experienced recent or recurring flooding. The Office of Emergency Management reports that the number of flooded roads is growing with each major storm or tidal event.

DPW is also responsible for maintenance of fifteen bridges owned by the county. All of the bridges are reported to be in good condition as defined by the Federal Highway Administration.

Map 1 shows the road network in Calvert County, including the historic roads and roads with reoccurring flooding.

Roadway Classification

Roadway functional classification defines the role each roadway plays in moving vehicles throughout the network and how roadways relate to adjacent land uses. No expressways or highways exist in the county; instead, MD 2/4 is the principal north-south arterial road. As a principal arterial, it is the County's long-term objective to limit the number of access points in order to maintain traffic flow and safety. In the Solomons/Lusby area an access management strategy resulted in the development of the Southern Connector Boulevard. Several local roads had their access redirected to the Southern Connector rather than directly on to MD 2/4, over the past twenty years there have been multiple proposals for grade-separated interchanges along MD 2/4 which would have the effect of making portions of MD 2/4 into a freeway. None of these proposals have advanced nor do any appear to be warranted.

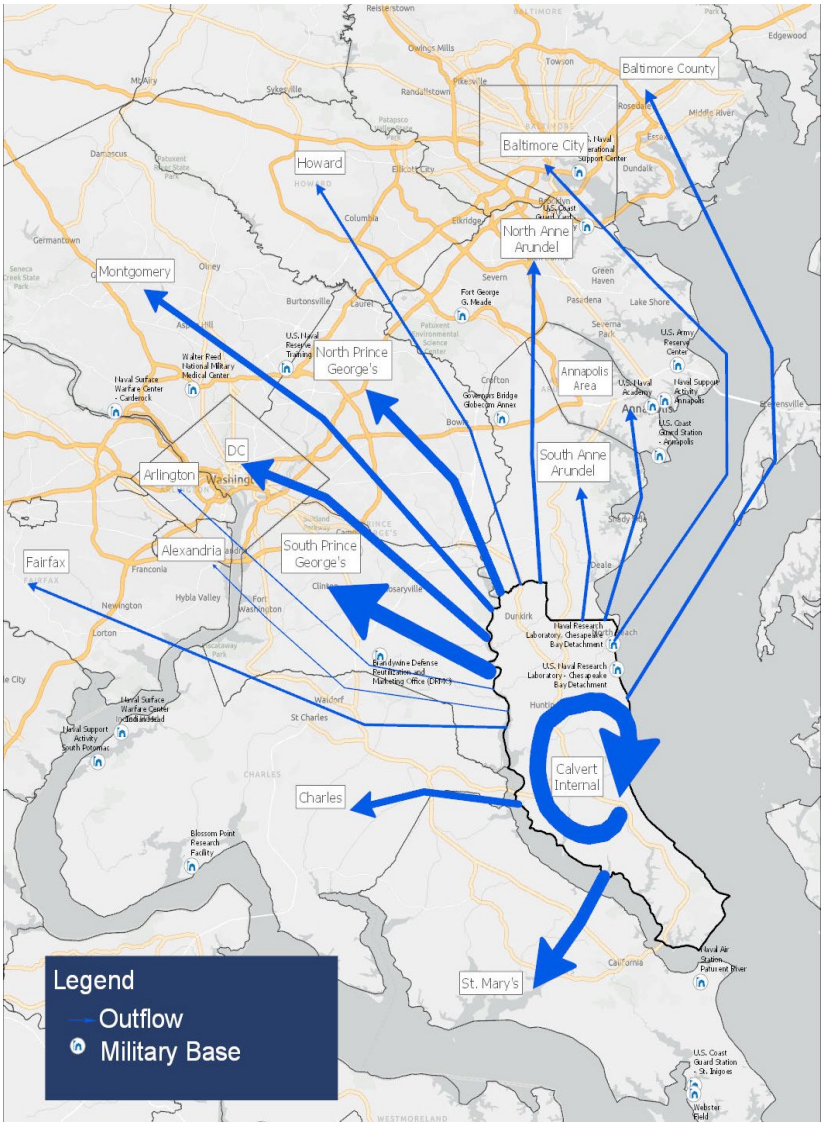
Calvert County has two east-west primary arterial roads, Chesapeake Beach Road connecting Chesapeake Beach to Owings and Hallowing Point Road connecting Prince Frederick Town Center to Charles County. Due to the rural nature of the area, these principal arterials have uncontrolled access with driveways and side streets freely permitted. There does not appear to be any reason to control access on these principal arterials as their functionality is not compromised

All other roadways serve a very localized function and are classified as minor collectors or local streets.

Map 1 Roadway Functional Classifications and Historic and Flooded Roads

Commuting Patterns

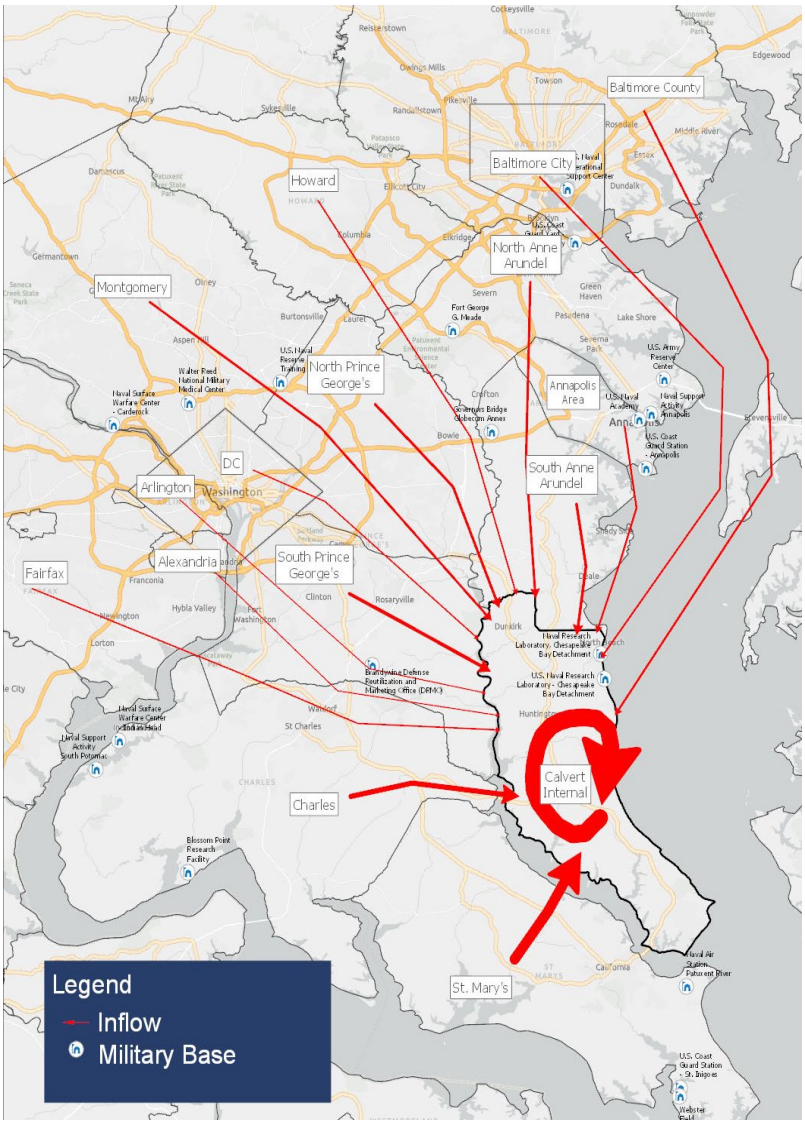
As of July 2018, the Census Bureau estimates that the average commute time for a resident of Calvert County is 42 minutes, by far the longest average commute of any jurisdiction in Maryland. The lack of major employers in Calvert County results in slightly more than 65% of commuting trips destined for locations outside of Calvert County; and this cohort has steadily increased over the past three decades. Military facilities (NSF Indian Head, Joint Base Andrews, NAS Patuxent River), defense agencies and contractors and non-defense federal agencies are the largest employment sector for Calvert County.



Map 2 Outbound Commutes from Calvert County

Destinations	% of Trips
Calvert County	34.7%
Southern Prince George's	11.8%
St. Mary's County	9.3%
Northern Prince George's	6.4%
Washington, D.C.	6.2%
Charles County	4.9%
Montgomery County	4.5%
Baltimore City/ Baltimore County	4.4%
Northern Anne Arundel (BWI/Ft. Meade)	4.4%
Annapolis/Southern Anne Arundel	4.4%
All Other Locations	10.6%

Similarly, due to the lack of major employers, less than 10,000 commuting trips are made into Calvert County each day. Nearly 50% of the trips made into Calvert County are by residents of southern Anne Arundel, Charles, and St. Mary's counties.



Trip Origin	% of Trips
St. Mary's County	28.3%
Charles County	12.3%
Annapolis/ Southern Anne Arundel	8.9%
Southern Prince George's	7.6%
Baltimore City/County	6.3%
Northern Prince George's	5.2%
Northern Anne Arundel (BWI/Ft. Meade)	4.7%
Montgomery County	4.2%
Northern Virginia	2.0%
Howard	1.7%
Washington, D.C.	1.3%
All Other	17.5%

Map 3 Inbound Commutes into Calvert County

Finally, data indicates that MD 2/4 carries a relatively insignificant amount of through traffic from St. Mary's County across the Governor Thomas Johnson Bridge and through to Prince George's or Anne Arundel County. Fewer than 4% of all vehicles make this trip from the southern border through to the northern boundary of the Calvert County. This is indicative of a strong economic relationship between Calvert County and NAS Patuxent River as 96% of all trips using the bridge are between Calvert and St. Mary's Counties.

Traffic Volume Since 2010

Since 2010, traffic volumes there have been significant variations of change in traffic volumes MD 2/4:

- between Huntington (MD 263) and the MD 2/4 split a modest with 1.5% increase in Annual Average Daily Traffic occurred.
- Through Prince Frederick (MD 402 to MD 263), Annual Average Daily Traffic dropped by 14.6% from 48,012 to 40,990. Some of this decline appears to be associated with the opening of Prince Frederick in 2014, carrying just under 3,000 trips per day.
- through Lusby and Solomons (from Coster Road/Mill Bridge Road to Lore Road), traffic increased by 11%[2]

Map 5 indicates 2018 Annual Average Daily Traffic along MD 2/4.

Traffic Speed & Intersection Level of Service

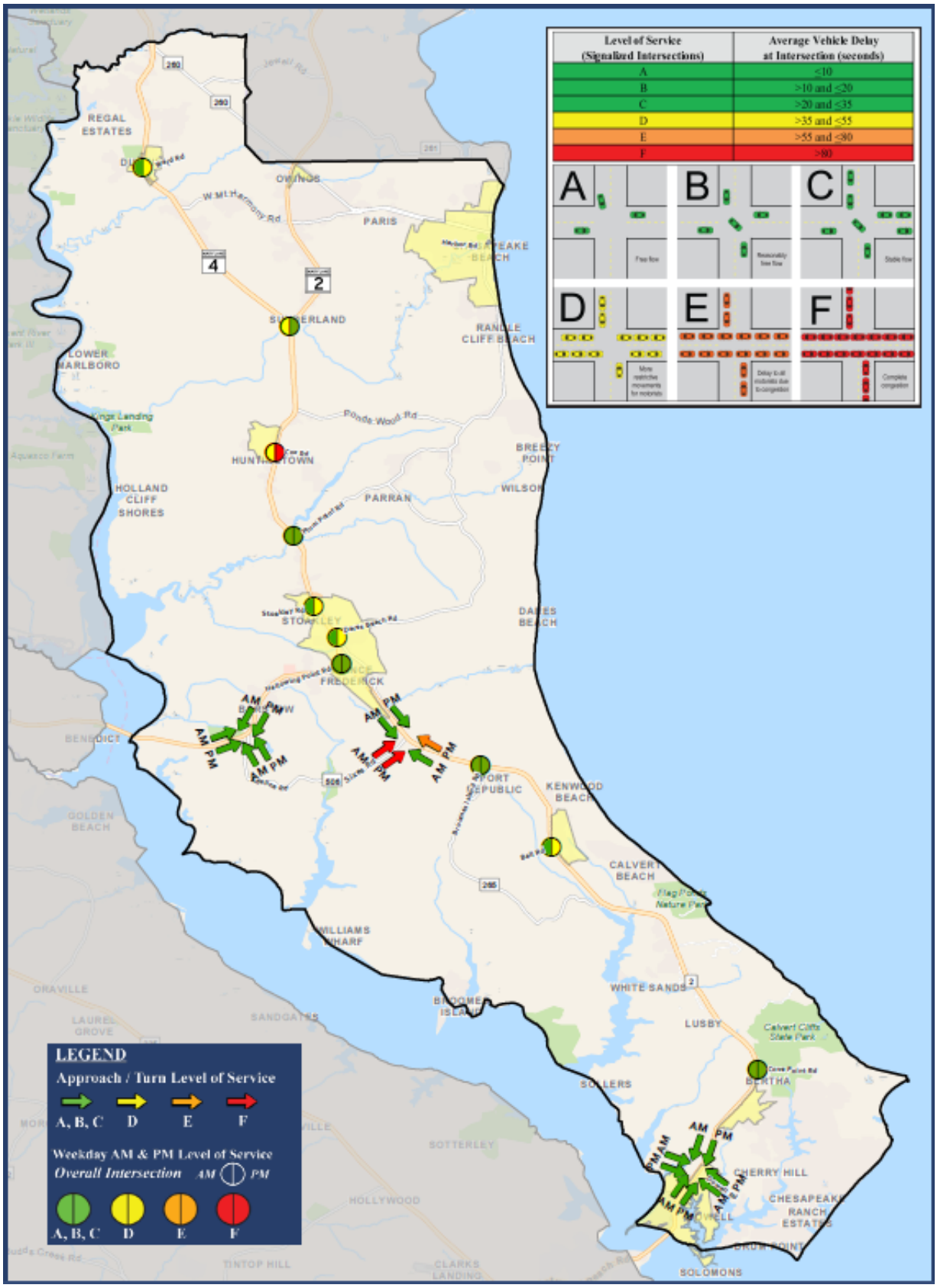
All along the MD 2/4 corridor, morning peak hour traffic hour speed consistently runs at or near the posted speed limit (50/55 mph in rural areas; 45 mph through the town centers). The same conditions occur in the PM peak hour, except through Prince Frederick where average speeds drop to under 30 mph between MD 261 and MD 402. Map 5 depicts the AM and PM average travel speeds in Calvert County.

Like the traffic speeds, intersections along the MD 2/4 corridor also operate as designed with only (Cox Road in Huntington) operating at level of service (LOS) "F" during morning peak hour. LOS F indicates that traffic delay can be 80 seconds or more beyond the programmed signal cycle. All other intersections during the morning and afternoon peak hours operate at LOS D or better; MDOT SHA defines LOS D or better as being acceptable. Table 2 and Map 4 depict the intersection capacity and delay in Calvert County.

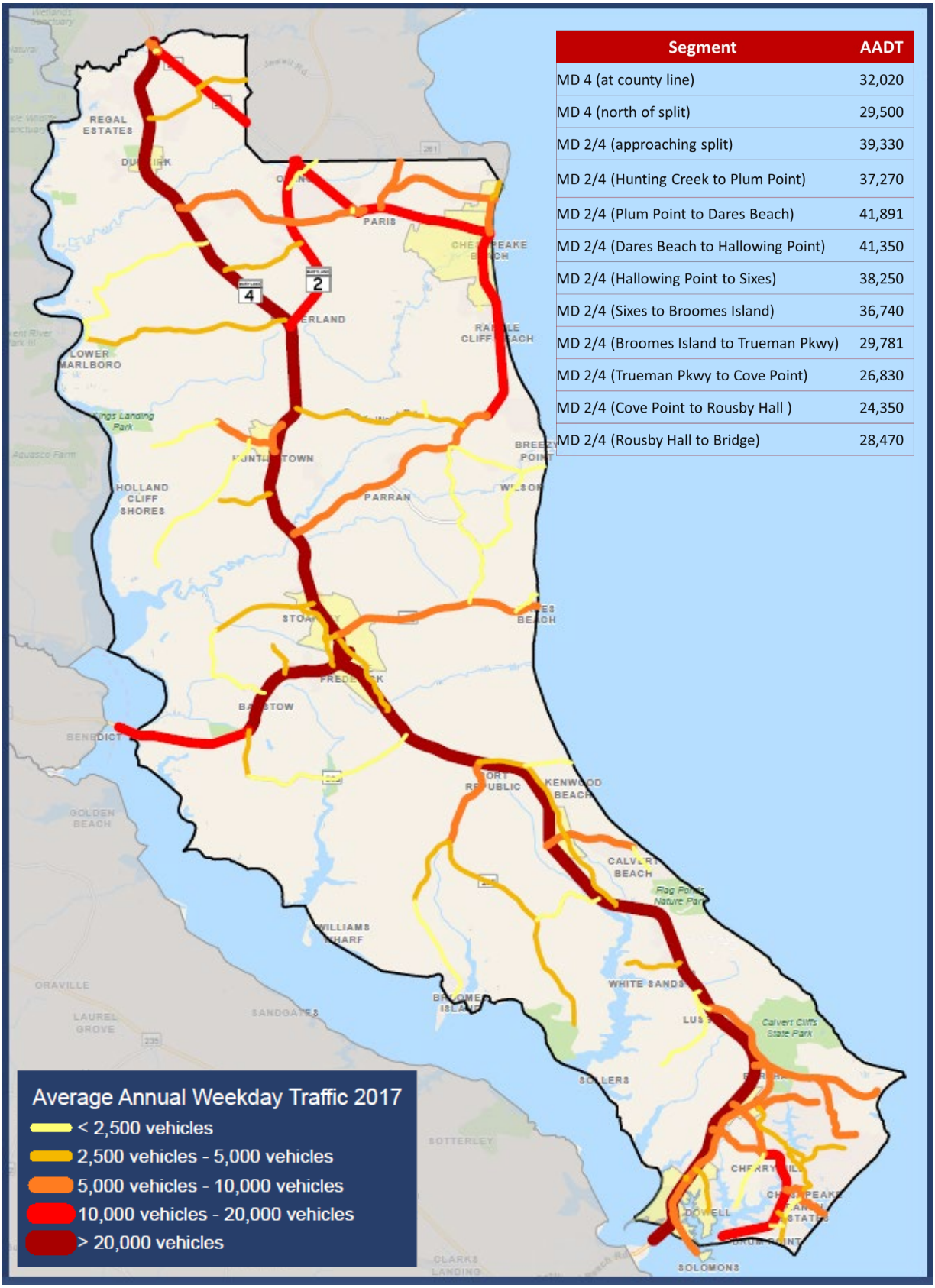
Intersection	LOS (AM/PM)		Average Delay (sec)	
MD 4 @ Ward Rd	C	D	26	48
MD 2/4 Split	D	C	39	28
MD 2/4 @ Cox Rd	D	F	47	217
MD 2/4 @ Plum Point Rd	C	B	25	17
MD2/4 @ Stoakley Rd	C	D	21	46
MD 2/4 @ Dares Beach Rd	C	D	28	40
MD 2/4 @ Church Rd	C	C	26	33
Adelina Rd @ MD 231 (NB Approach)*	B	C	15	18
MD 2/4 @ Sixes Road (EB Approach)*	F	F	186	300+
MD 4 @ Broomes Island Rd	B	B	12	12
MD 2/4 @ Calvert Beach Rd	C	D	24	39
MD 2/4 @ Cove Point Rd	B	C	13	25
MD 2/4 @ Dowell Road* (avg all approaches)	C	B	8	9

** Unsignalized Intersection*
Table 2 Intersection Capacity/Delay

[2] MDOT SHA Office of Planning and Preliminary Engineering Data Services Division AADT of Stations for the Years 2010 – 2016.



Map 4 Intersection Capacity/Delay



Segment	AADT
MD 4 (at county line)	32,020
MD 4 (north of split)	29,500
MD 2/4 (approaching split)	39,330
MD 2/4 (Hunting Creek to Plum Point)	37,270
MD 2/4 (Plum Point to Dares Beach)	41,891
MD 2/4 (Dares Beach to Hallowing Point)	41,350
MD 2/4 (Hallowing Point to Sixes)	38,250
MD 2/4 (Sixes to Broomes Island)	36,740
MD 2/4 (Broomes Island to Trueman Pkwy)	29,781
MD 2/4 (Trueman Pkwy to Cove Point)	26,830
MD 2/4 (Cove Point to Rousby Hall)	24,350
MD 2/4 (Rousby Hall to Bridge)	28,470

Map 5 Average Speed and Reliability

Traffic Safety

Collisions in Calvert County were analyzed from January 2015 – September 2018 using MDiMap open portal crash data. Over this time period there was a total of 4,398 crashes the largest percentage of which involved vehicle collisions (Figure 1).

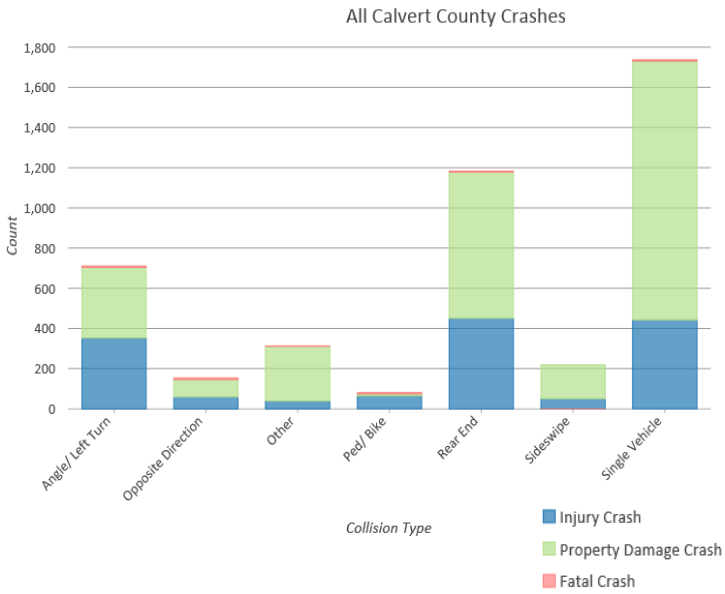
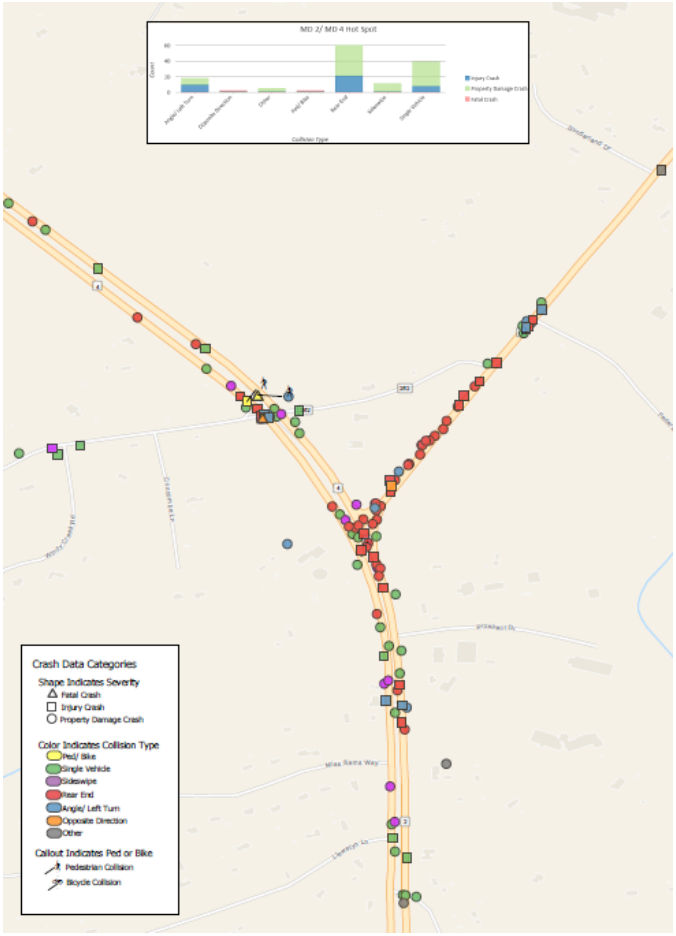


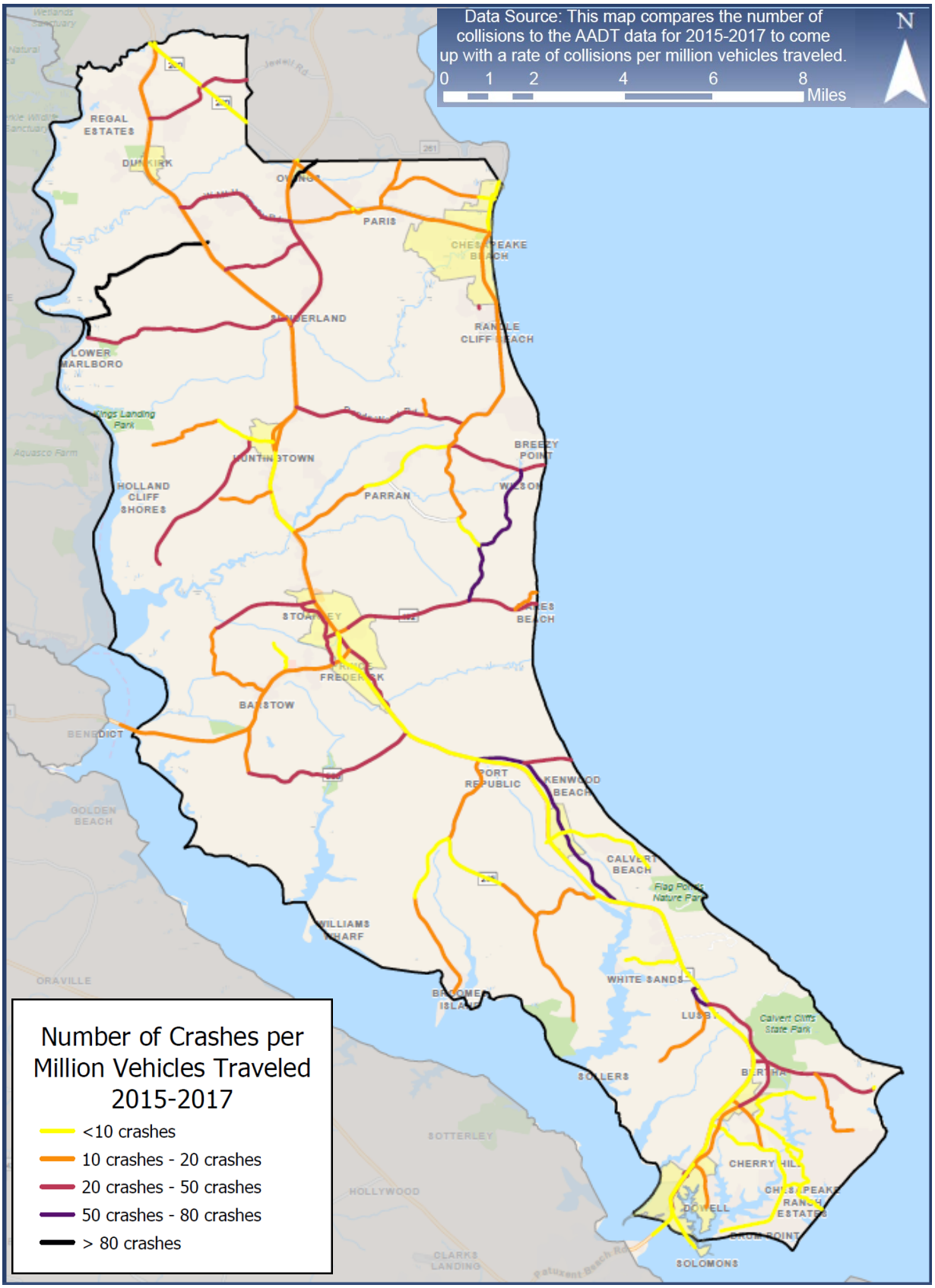
Figure 1 All Crashes in Calvert County January 2015 – September 2018 by Collision Type

Using a heat map methodology, five collision hot spots were identified for further analysis. The hot spot locations make up parts of the following locations: Dunkirk (209 collisions), the MD 2/ MD 4 split (137 collisions), Huntington (120 collisions), Prince Frederick (580 collisions) and Lusby (274 collisions). Although Prince Frederick had more recorded collisions than any other hot spot, none were fatalities. The MD 2/ MD 4 split had the most recorded fatalities with 2 fatalities at the intersection of MD 4 and MD 262 (Map 6).

Crash rates per vehicles traveled was assessed for 2015-2017 using Average Annual Daily Traffic Data (AADT) from MDiMAP open data portal. The data was calculated for the number of crashes per million vehicles traveled (Map 7). The areas with the highest crash rates do not coincide with the collision hot spots and instead occur on collectors and local road where there is less overall traffic. The highest collision rate occurs on Chaneyville Rd in northwest Calvert County (Map 7).



Map 6 Crashes at MD 2/ MD 4 Split



Map 7 Number of Crashes on Calvert County Roads

Traffic Management and Intelligent Transportation Systems

The SHA has implemented several technologies in the areas surrounding Calvert County but has only limited deployments within the county. Currently, MD SHA maintains three video monitoring cameras: MD 260 at Cox Road in Chesapeake Beach, and two at the major bridge crossings of the Patuxent River (MD 4 and MD 231). Further north, MDOT has implemented the Smart Signals on MD 2 approaching Annapolis and dynamic message signs and traffic monitoring cameras along MD 301 through Anne Arundel and Prince George's Counties.

One limitation on MDOT SHA's ability to deploy transportation technology solutions in Calvert County is the limited communications infrastructure such as fiber optic lines which enhance the ability to implement additional video cameras, gather real-time data, operate dynamic message signs and implement real-time traffic signal control. These limitations will become more apparent as the number of connected vehicles using communications devices to convey and share information grows as CAV technology improves and expands. Calvert 2040, Calvert County's comprehensive plan, calls for the continued development of a broadband network for use in a variety of applications. This network could include greater communications capabilities with transportation technology.

Transit Services

There are several public transit options in Calvert County including fixed route and ADA paratransit services provided by Calvert County Public Transit and by the commuter bus service to Washington, DC provided by MTA. There are no intercity bus services (Greyhound, Peter Pan, etc.) which operate in Calvert County.

Calvert Public Transit

The local Calvert County Public Transit bus service is comprised of eight routes focusing on various parts of the county. These routes are the Dunkirk Route, Lusby Shuttle, Prince Frederick Shuttle I, Prince Frederick Shuttle II, Mid-County, North Route, South Route and Charlotte Hall. These buses provide bus transportation to link residents with employment centers, shopping centers and medical facilities and other public services. The bus system is run on a "flag system" which means there are few established bus stops and buses can be hailed along the route by passengers. Bus service operates on weekdays and have limited service on Saturdays.

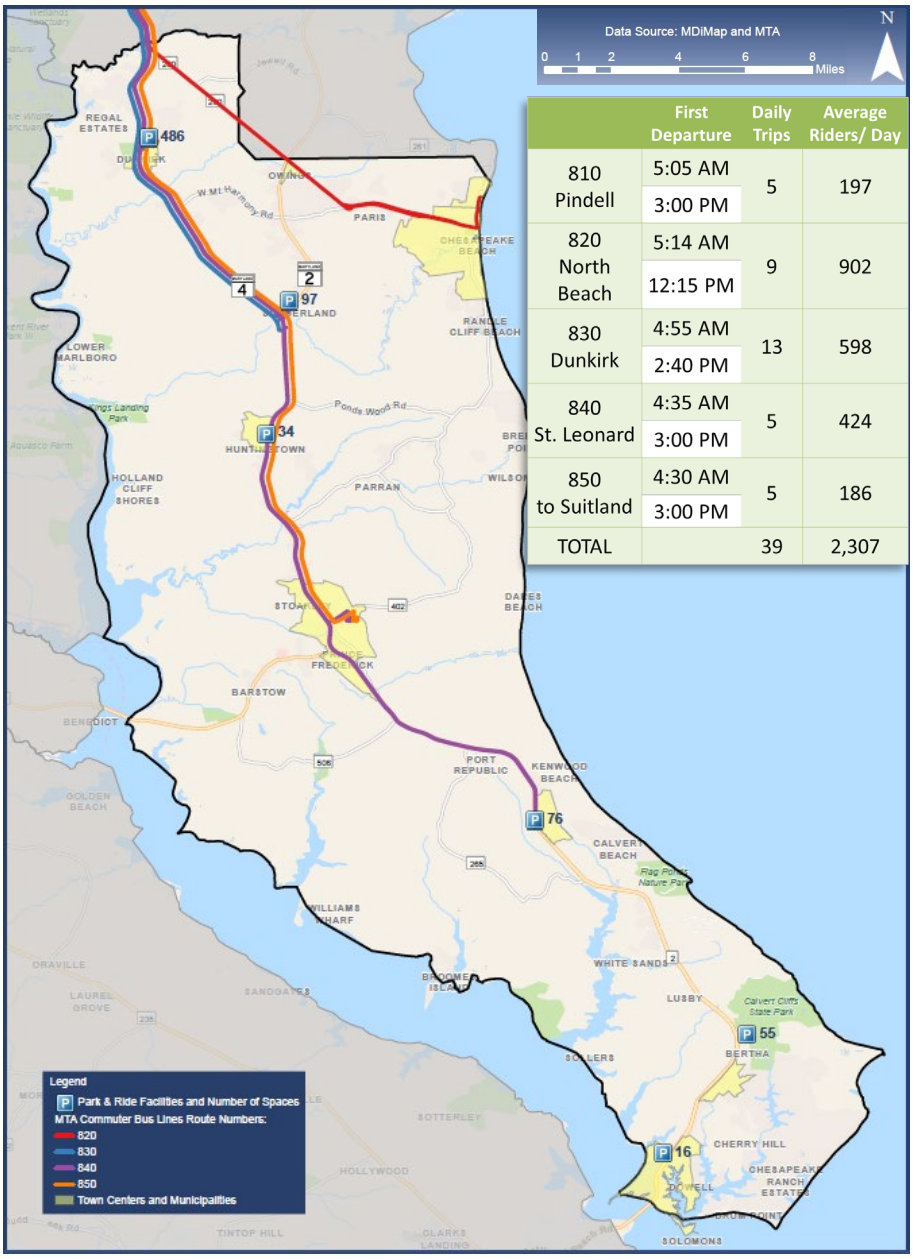
The total passenger trips per year is about 99,000 passenger trips with the Prince Frederick Shuttle I having the highest ridership. The total service distance is just under 400,000 miles. Other transit programs including the ADA Paratransit and the SSAP (Statewide Special Transportation Program) service approximately 14,000 passenger trips a year.

Routes	Annual Ridership
Dunkirk	3,169
North I & II	18,207
Prince Frederick Shuttle I	28,839
Prince Frederick Shuttle II	9,084
Mid County	6,067
South	17,044
Lusby Shuttle	10,329
Saturday Service	5,427
Charlotte Hall	883
Subtotal - Route Service	99,049
ADA Paratransit	**13,599**
All Transit Services	**112,648**

Table 3 Calvert County Public Transit Bus Annual Ridership

MTA Commuter Bus

There are four MTA commuter bus routes serving Calvert County and connecting commuters to Washington DC. Approximately 2,300 trips are taken daily on the regional commuter service as shown below with the greatest ridership being on the route from North Beach. Table 3 and Map 8 depict the regional commuter service in Calvert County. The county is also served by park and ride lots in Dunkirk, Sunderland, Huntington, St. Leonard, north of Lusby and Solomons. Park and Ride locations are shown on Map 8.



	First Departure	Daily Trips	Average Riders/ Day
810 Pindell	5:05 AM 3:00 PM	5	197
820 North Beach	5:14 AM 12:15 PM	9	902
830 Dunkirk	4:55 AM 2:40 PM	13	598
840 St. Leonard	4:35 AM 3:00 PM	5	424
850 to Suitland	4:30 AM 3:00 PM	5	186
TOTAL		39	2,307

Table 4 MTA Routes Schedule and Map 8 MTA Commuter Bus Lines & Park and Ride Facilities Average Ridership

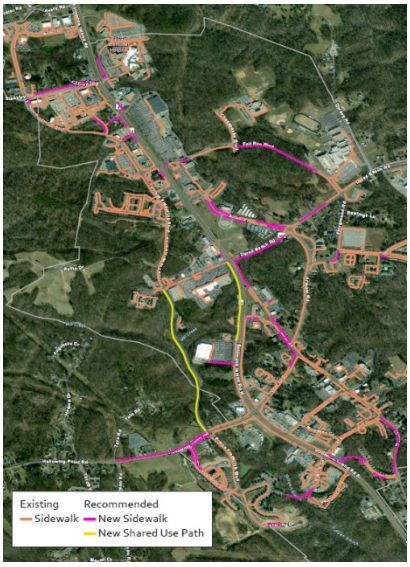
Bike and Sidewalk Network

Calvert County is not well-suited for walking and bicycling as a means of transportation. Although sidewalks exist in some of the developed shopping centers and activity nodes, the network is not well connected for continuous pedestrian trips. The lack of safe, signalized pedestrian crossings between the two sides of MD 2/4 also poses a challenge for a functional pedestrian system. The pedestrian networks within the town centers are in segments and new development along MD 2/4 are responsible for including sidewalks in their future plans. Huntington is the only town center that does not need significant alteration in the pedestrian network. Three maps of the major town centers and their existing and recommended sidewalk network are shown below.

Trails and Paths

The 2019 Maryland Department of Transportation Bike and Pedestrian Master Plan notes the lack of bicycle facilities in Calvert County as nearly all of county's trails are contained within or connect between county and state parks. The lone exception is the Chesapeake Beach Railway Trail from the Chesapeake Beach Water Park and extending westward along the shore of Fishing Creak, although it too is intended for recreational purposes.

The Calvert County Department of Recreation and Parks is acquiring portions of the former Baltimore & Drum Point Railroad with a special focus on the portion that runs through Prince Frederick, to develop it as a pedestrian/bicycle trail. The County government owns the portion of the Baltimore & Drum Point Railroad that crosses King Memorial Park in Prince Frederick (approximately 525 linear feet). As other portions of the railroad bed in Prince Frederick are acquired, develop these as a pedestrian/bicycle trail from north of Calvert Memorial Hospital, behind the Fox Run Shopping Center, through the woods along Armory Road, across Main Street, to King Memorial Park.[3]



Prince Frederick

Lusby

Solomons

[3] https://www.thewashcycle.com/2017/10/baltimore-and-drum-point-.html accessed on April 17, 2019

Environmental Issues

Flooding and Flood Resiliency Plan

The Federal Emergency Management Agency (FEMA) has identified special flood hazard areas within the boundaries of Calvert County. Additionally, a hazard identification and vulnerability assessment recognized all or part of Calvert County as having high vulnerability to hurricane/tropical storms, severe storms/winter storm and tornadoes and moderate vulnerability to drought, extreme temperatures and earthquakes. The County has been preparing an update to the Flood Mitigation Plan and a Hazards Mitigation Plan to improve Calvert County's resistance to natural hazards, including flooding, by identifying actions to reduce the impact of various hazards to people and property. The goal and purpose of these plans is to identify which communities and individual structures are most vulnerable to flooding, and discusses the potential economic, and public health and safety impacts to the county, as well as to improve Calvert County and its municipalities' resistance to floods and other hazards by identifying actions to reduce the impacts to county residents and structures. The Flood Mitigation Plan must be approved by FEMA and Maryland Emergency Management Agency (MEMA) prior to being adopted by the County.

In addition to the countywide plans, small area flood mitigation plans for the county's most flood prone communities are in various stages of planning and completion. These communities include: Cove Point and Broomes Island (adopted); Plum Point including Breezy Point and Neeld Estate (drafted); and the Towns of Chesapeake and North Beach (in development).

Watershed Implementation Plan

There are three phases of Watershed Implementation Plans (WIPs) developed by each jurisdiction within the Chesapeake Bay watershed. Maryland's Draft Phase III Watershed Implementation Plan to Restore Chesapeake Bay by 2025 was developed by a collaboration of state agencies that comprise the Governor's Chesapeake Bay Cabinet. Phase I and Phase II WIPs were developed and submitted to EPA in 2010 and 2012, respectively. Both Phase I and Phase II WIPs describe actions and controls to be implemented by 2017 and 2025 to achieve applicable water quality standards. Having reached the mid-point between development of the 2010 Total Maximum Daily Load (TMDL), which establishes current Chesapeake Bay pollution reduction goals and the ultimate 2025 restoration deadline, Maryland's Phase III WIP identifies the strategies, opportunities, and challenges in not only meeting the 2025 Chesapeake Bay Restoration targets, but also sustaining restoration into the future. Maryland's 2025 targets for bay restoration include reductions in total nitrogen total phosphorus. In meeting these targets, the state will also meet its sediment goals.

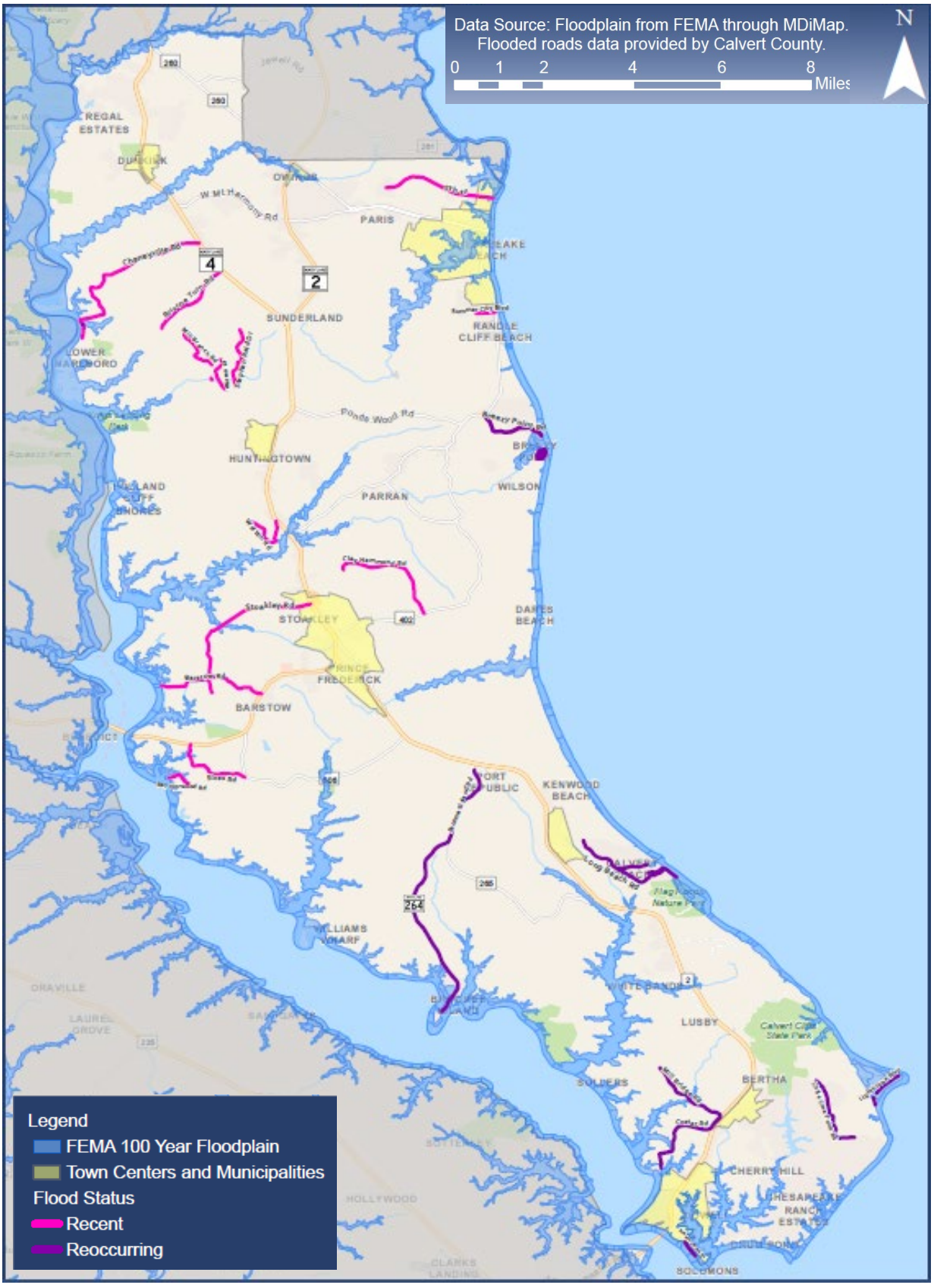
During the development of the Phase III WIP, the state reached out to local government staff, including Calvert County staff and the interested public to lay out strategies and a framework for creating a feasible and balanced approach to creating goals for each jurisdiction, by sector. The sectors include agriculture, developed, septic, and wastewater. Calvert County goals, among others, include stream and wetland restoration and buffers, prescribed grazing and shoreline restoration. Maryland's Draft Phase III WIP was released for public comment in April 2019 and the Final Phase III WIP is scheduled for completion in August 2019.

Calvert County Phase II Watershed Implementation Plan noted the following actions to achieve Phase II WIP nitrogen, phosphorous and sediment target load goals for the County:

- The County's practice of land application of wastewater effluent rather than direct discharge at 2 of the County's 3 major waste water treatment plants (WWTPs)
- The use of shared community septic systems that utilize pretreatment and land application
- Identifying and upgrading failing septic systems
- Initiating watershed implementation plans in selected subwatersheds to identify pollution sources and develop a strategy to reduce pollutants
- Upgrading to enhanced nutrient removal (ENR) at Chesapeake Beach WWTP
- Targeting growth to town centers served by public sewer
- Conducting public outreach and education on the importance of pumping septic systems through programs such as the Calvert County Environmental Commission's "Pump for the Bay Contest"
- Upgrading existing conventional septic systems to nitrogen-removing systems through a Bay Restoration Fund grant
- Minimizing future residential development in the Farm and Forest Zoning District through two downzonings and a TDR program, providing funding for land preservation through the Purchase and Retirement of TDRs (PAR Program)
- Implementing lots-to-TDRs program to convert existing undeveloped lots to open space[4]

Department of Public Works has been doing a variety of projects to address these actions, and the County is now drafting Phase III.

[4] Calvert County WIP II Strategy



Map 10 Calvert County Floodplain

Issues and Observations

- The County is improving its asset management system for roads and bridges. While county-owned bridges are in very good condition, there is a significant yet undefined backlog of street repaving that needs to occur.
- The most significant traffic congestion issues occur on state roadways; however, when measured against standards established by MDOT SHA as indicated by average speed and intersection level of service, there is minimal traffic congestion in Calvert County.
- Localized recurring and non-recurring congestion are not well-monitored by MDOT SHA. Traffic systems management and operations strategies are not being deployed in Calvert County.
- Public concern regarding traffic congestion appears to be focused on difficulties getting around within the county rather to external destinations.
- Traffic crashes are highly-concentrated along MD 2/4 the town centers.
- Traffic growth is uneven throughout the county but overall relatively modest when compared to other parts of Maryland.
- Increasing tidal activity and severe storms is causing more roads to flood than ever before; thirty roads have experienced recent or recurring flooding.

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Engineering Innovative Solutions

TO: Calvert County Office of Planning & Zoning

FROM: Jamie Kendrick, Project Manager
James Bunch, Senior Transportation Planner for Travel Demand Forecasting

SUBJECT: Travel Demand Forecast for Calvert County Transportation Plan

DATE: July 8, 2019

Executive Summary

This memorandum describes the travel forecasting process, assumptions, and outputs for use in developing the Calvert County Transportation Plan. The primary purpose of the travel forecasting process for this project is to establish traffic growth rates to be used in analyzing roadway operations and assess the need for improvements to the road network. The foundation of the Calvert County travel forecast is the most recent Metropolitan Washington Council of Governments (MWCOG) travel forecasting model[1] using a 2017 base year and 2040 horizon year. SAI enhanced the model with additional zone and network details to capture traffic patterns/flows in and around Dunkirk, Prince Frederick, Lusby and Solomons and elsewhere to support the traffic operations analysis at the town center scale.

The adopted land use plan from the Calvert County Comprehensive Plan adopted in 2009 and the land use plan pending before the Board of County Commissioners as of July 1, 2019 were then input into the travel forecasting model to determine traffic volumes from the land use plans using three different rates of population growth. Summary measures relating to Average Annual Weekday Vehicle trips (AAWDT) from, to, and within Calvert County, total vehicle miles travelled, vehicle hours travelled, and volume-to-capacity are presented below.

Using the growth rate forecasted by the Maryland Department of Planning and MWCOG, it is forecast that at the *network level* (that is, all state roadways, and primary and secondary county roadways), sufficient capacity exists to support the projected countywide population in 2020; traffic volume would exceed road capacity on only 8.4 of 360 (2.3%) peak hour directional miles in the morning and on only five miles in the afternoon (1.4%). In these areas, certain intersections may have excess delay that requires mitigation. This will be determined during the traffic operations analysis.

[1] Version 2.3.75, Round 9.1 Cooperative Land Use adopted by the National Capital Region Transportation Planning Board in October 2018.

Part 1: Travel Demand Model Overview & Calvert County Enhancements

The travel demand forecast for this project uses the MWCOG travel model (for 2017 base year, and 2040 horizon. While Calvert and St. Mary's County are technically outside the MWCOG boundaries, since 2016 there has been an agreement with the Calvert-St. Mary's Metropolitan Planning Organization (C-SMMPO) to incorporate the MPOs transportation plans, programs and projects in the MWCOG regional air quality conformity analysis. Consequently, the MWCOG includes both counties in their regional networks and land use forecasts.

The MWCOG model region with Calvert County highlighted is shown in Figure 1. The model region includes the District of Columbia, neighboring parts of Maryland, Virginia, and Jefferson County in West Virginia. The 6,800-square-mile modeled area is divided into 3,722 transportation analysis zones (TAZs). Calvert County contains 46 TAZs.

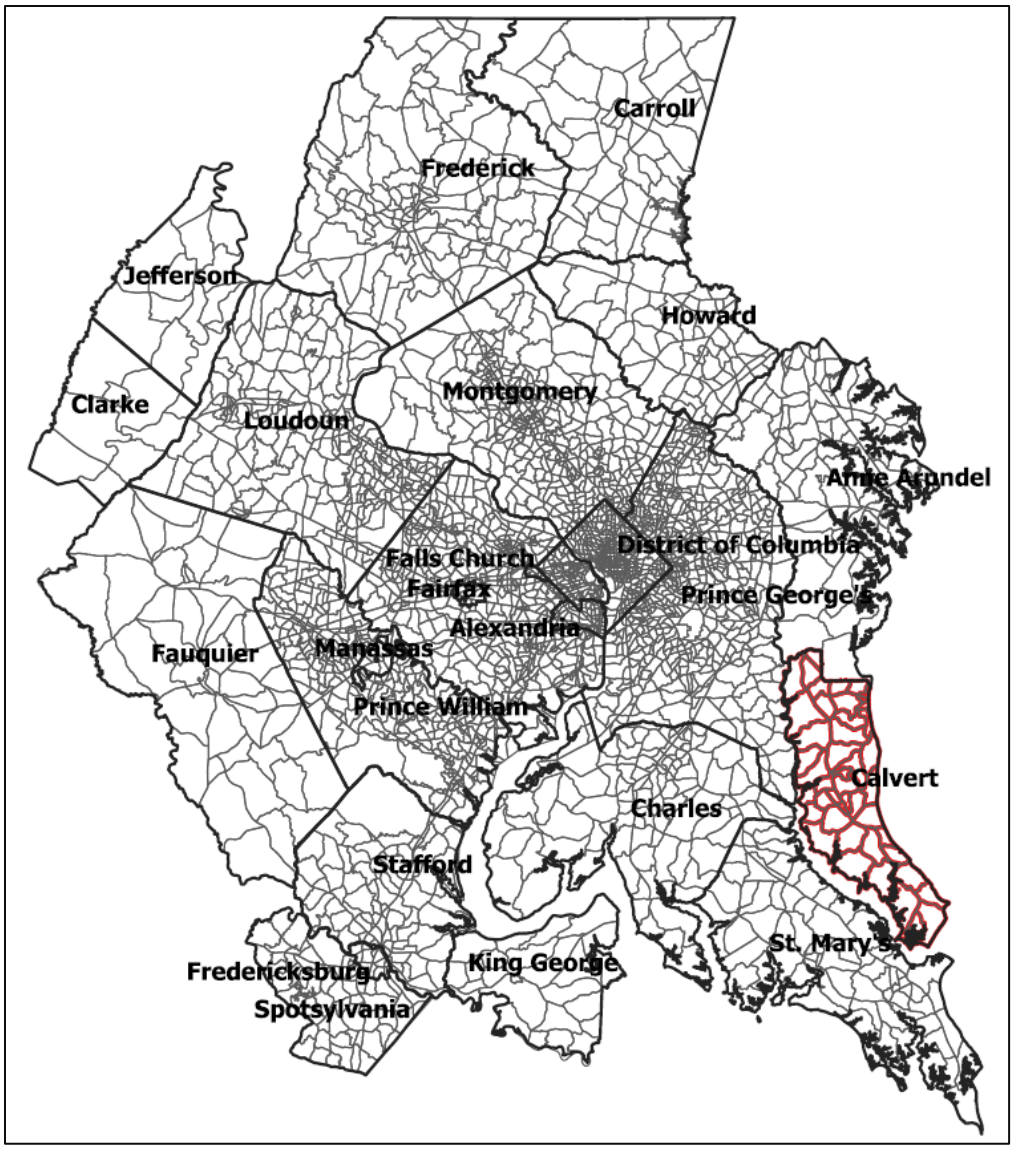

Figure 1. Transportation Analysis Zones in the MWCOG Travel Demand Model

The model is a traditional, trip-based, "four-step" travel demand forecasting model (Trip Generation, Trip Distribution, Mode Split, and Assignment) utilizing four feedback iterations to equilibrate trip distribution with congested travel times and costs. The major steps and feedback loops within the model are shown in Figure 2. Additional features incorporated into the standard process include estimation of motorized and non-motorized trips, time-of-day modeling, and utilization of detailed transit schedules from General Transit Feed Specification (GTFS) data. It was calibrated to the most recent transit ridership and other data in 2012 and validated to the 2010 U.S. Census data in 2013.[2] Highlights important to this Calvert County Forecasts are discussed below.

The last step in the model application process is traffic assignment. A multi-class user-equilibrium (UE) traffic assignment is utilized for each of the four feedback iterations and includes six user classes: single-occupant vehicle (SOV), high-occupant vehicle with two persons (HOV2), high-occupant vehicle with three+ persons (HOV3+), medium and heavy trucks, commercial vehicles, and airport passengers traveling to/from the three major commercial airports serving the region. Additionally, the model includes four time-of-day periods for traffic assignment: AM peak period (6 AM to 9 AM), Midday (9 AM to 3 PM), PM peak period (3 PM to 7 PM) and Overnight (7PM to 6AM).

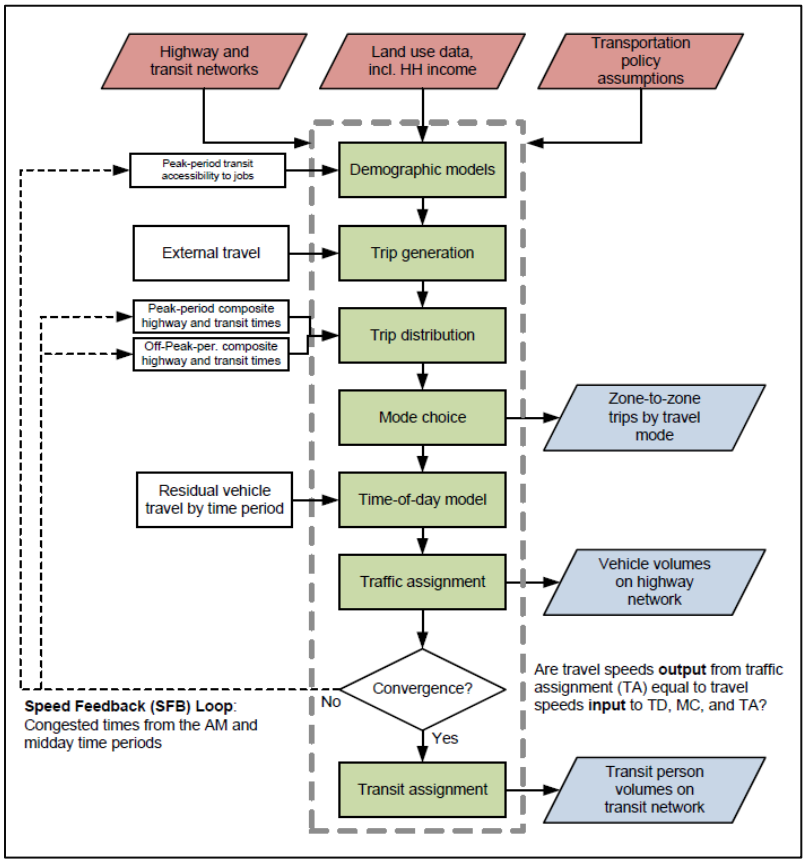

Figure 2. Four-Step Travel Demand Modeling Process

[2] For details on the MWCOG model see http://www.mwcog.org/transportation/activities/models/current.asp.

Subarea Analysis Process

For corridor or small area studies that do not anticipate major changes to the underlying travel patterns, mode-split, or distribution of traffic over different times of day, A post mode choice assignment process can be used since the overall vehicle trips and patterns will not change significantly from scenario to scenario. This process provides for adding details to represent local conditions and better represent/understand the effect of land use changes and the sensitivity of the road network to different rates of growth. As discussed above, the MWCOG model is primarily built to support planning efforts in a dynamic and growing region; Calvert County is in many respects an anomaly in the MWCOG model as growth rates and travel patterns are expected to remain very stable over the next twenty years. Calvert County's unique peninsular geography is also different than any other jurisdiction in the model. Finally, with Calvert and St. Mary's counties being "add-ons" to the regional model and not given as much attention to detail as the core MWCOG jurisdictions, it is even more important to enhance the model at the subarea level to yield valid outputs for the Calvert County Transportation Plan.

Consequently, a post mode choice assignment approach was therefore used for this effort in order to add the desired level of network detail. Post-processing using NCHRP 765 procedures was used in order to prepare the link and turning movement growth factors used for the peak hour operational analyses. This process is shown in Figure 3.

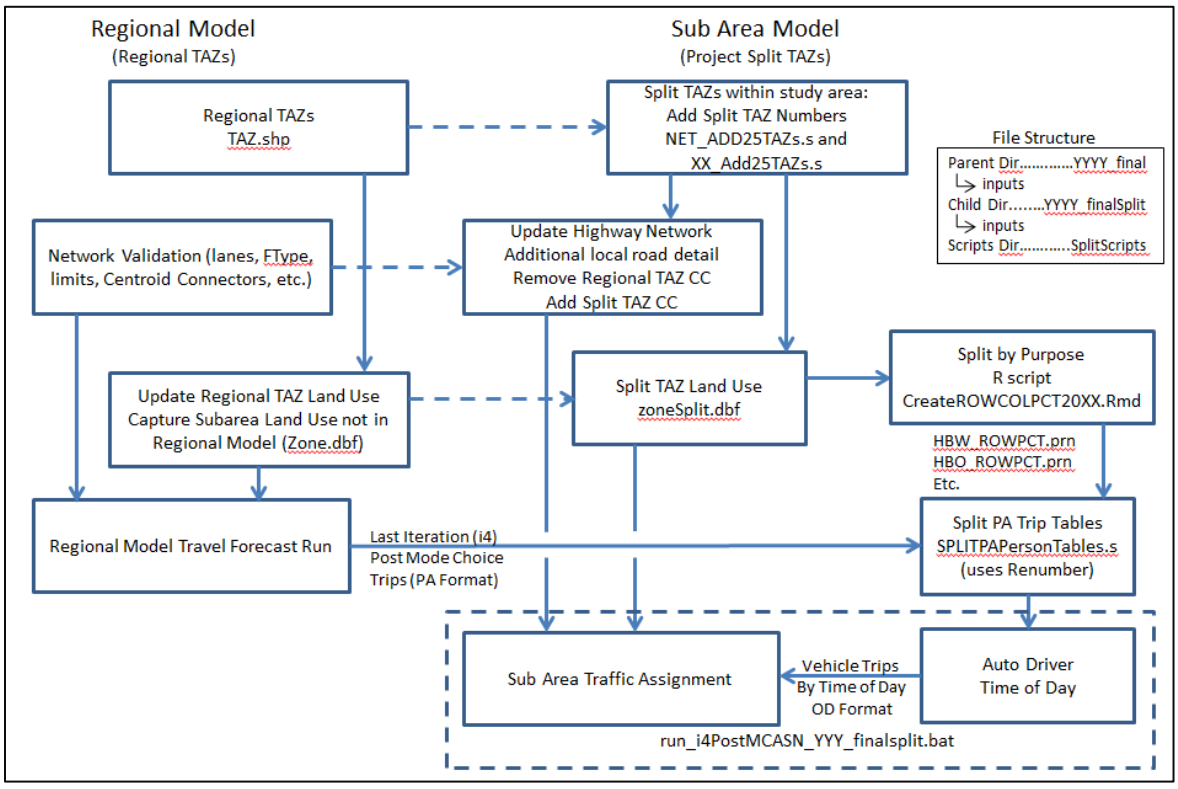

Figure 3. Subarea Assignment Process (MWCOG Base Model)

Revision of Traffic Analysis Zones

TAZs provide the origins and destinations for the travel calculations within the model structure. The core of the post-mode choice assignment approach is to ensure that TAZs reflect the land use patterns of the area that each contains, as land use acts as the basic unit for the number of trips, their purpose and time of day taken. The MWCOG model uses only 46 TAZs for Calvert County which are very large and designed to capture the regionally significant travel between Calvert County and the rest of the region; they are too large to reflect local travel in addition to regionally-oriented trips. For example, the Dunkirk Town Center is covered by only two TAZs which also contain the surrounding rural areas north of Hall Creek and southwest of MD 260. Solomon's and Lusby are represented by three TAZs (3323 – 3325) with all of the area from Chesapeake Ranch Estates to Drum Point being within one TAZ (3324).

To develop a better understanding of location-specific travel conditions and travel patterns, Calvert County was therefore further split into 64 TAZs (red boundaries). Splitting TAZs allows for more variance in population, household, and employment density assumptions. TAZs were split across logical boundaries to distinguish between town centers and rural areas. Figure 4 shows the original MWCOG TAZs and split TAZs developed within Calvert Count for this study.

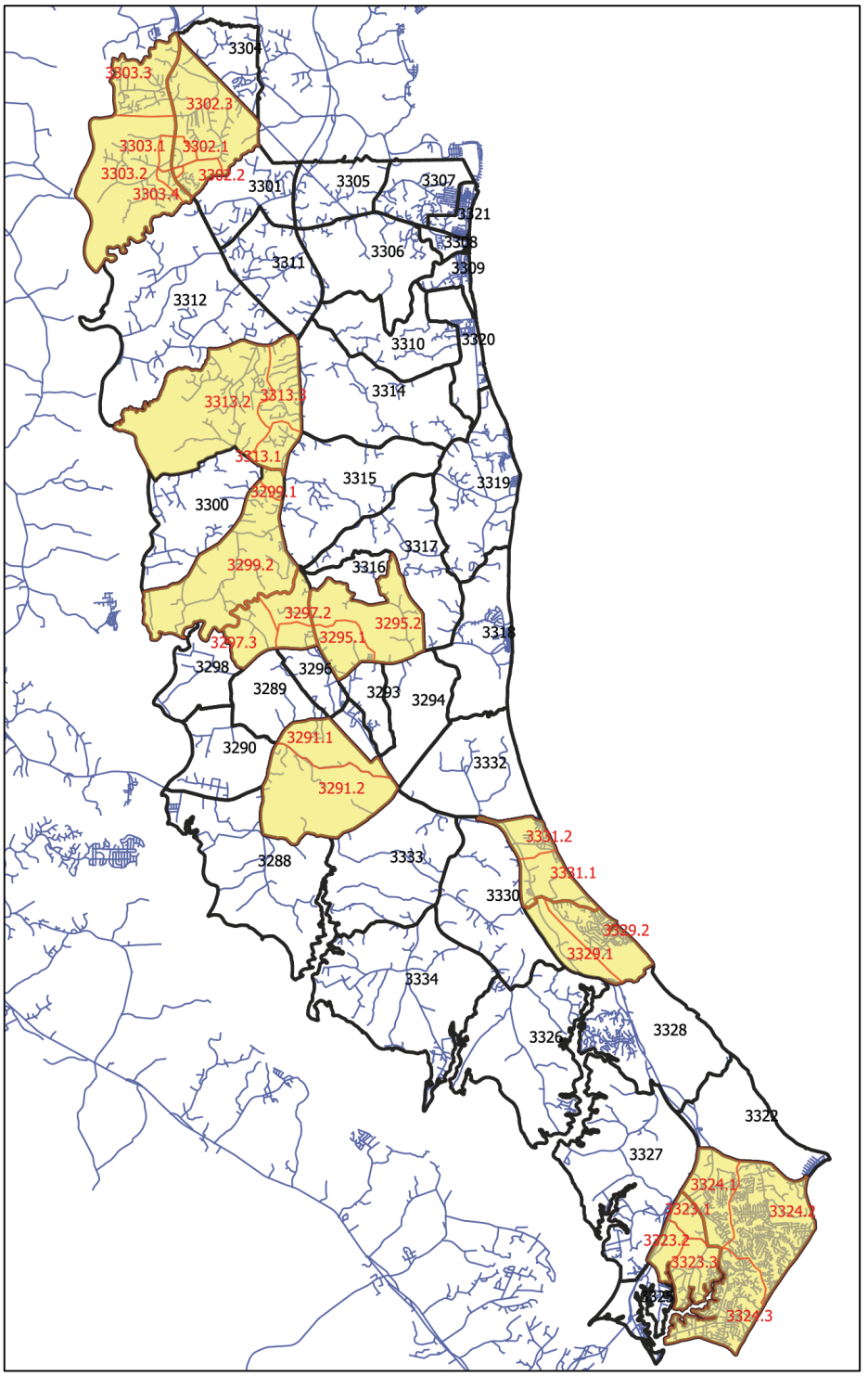

Figure 4. Existing TAZs (black) in MWCOG model with splits for Calvert County (red).

Increased Detail to the Road Network for Calvert County

In addition to refining the TAZs, additional roadway links (and in some cases validation of speed limits, turning lanes and other detail) were added to the travel demand model to first support the more detailed TAZ structure (new zone centroids and centroid connectors), and more relastic network loading in and around the town centers and activity centers. The additional network detail is shown in Figure 5 (and in Appendix 1) and includes:

Dunkirk
- Jewell Rd
- Brickhouse Rd
- Ward Rd
- Dunkirk Way
- Lyons Creek Rd
- Crown Dr
- Ferry Landing Rd
- Ashwood Rd

Brighton Woods/Huntingtown
- Briscoe Town Rd
- Mill Branch Rd
- Huntingtown Rd
- Cox Rd
- MD 524

Prince Frederick
- N. Prince Frederick Blvd
- Dorsey Rd extended
- Armory Rd
- Fariground Rd
- Old Field Ln
- German Chapel Rd

St. Leonard
- Ball Rd
- Long Beach Rd

Solomons/Lusby
- MD 760 to Ship Point
- Olivet Rd extended
- Thunderbird Dr
- Gunsmoke Trail
- Little Cove Point Rd

In addition to the network detail added to the 2017 network, the 2040 horizon-year network includes projects adopted as part of the financially-constrained regional long-range transportation plan and other locally-significant projects which are likely to be operational before the horizon year. The C-SMMPO constrained long-range plan increases the number of lanes across the Governor Thomas Johnson Bridge from 1 to 2 in each direction (total 4 lanes), and increasing the number of lanes on MD 2-4 through Frederick from 2 to 3 in each direction (total 6 lanes) from Stoakley Road to German Chapel Road; the model also assumes that the the unbuilt section of Fox Run Boulevard will be constructed and connect from MD 2-4 to MD 402/Dares Beach Rd.

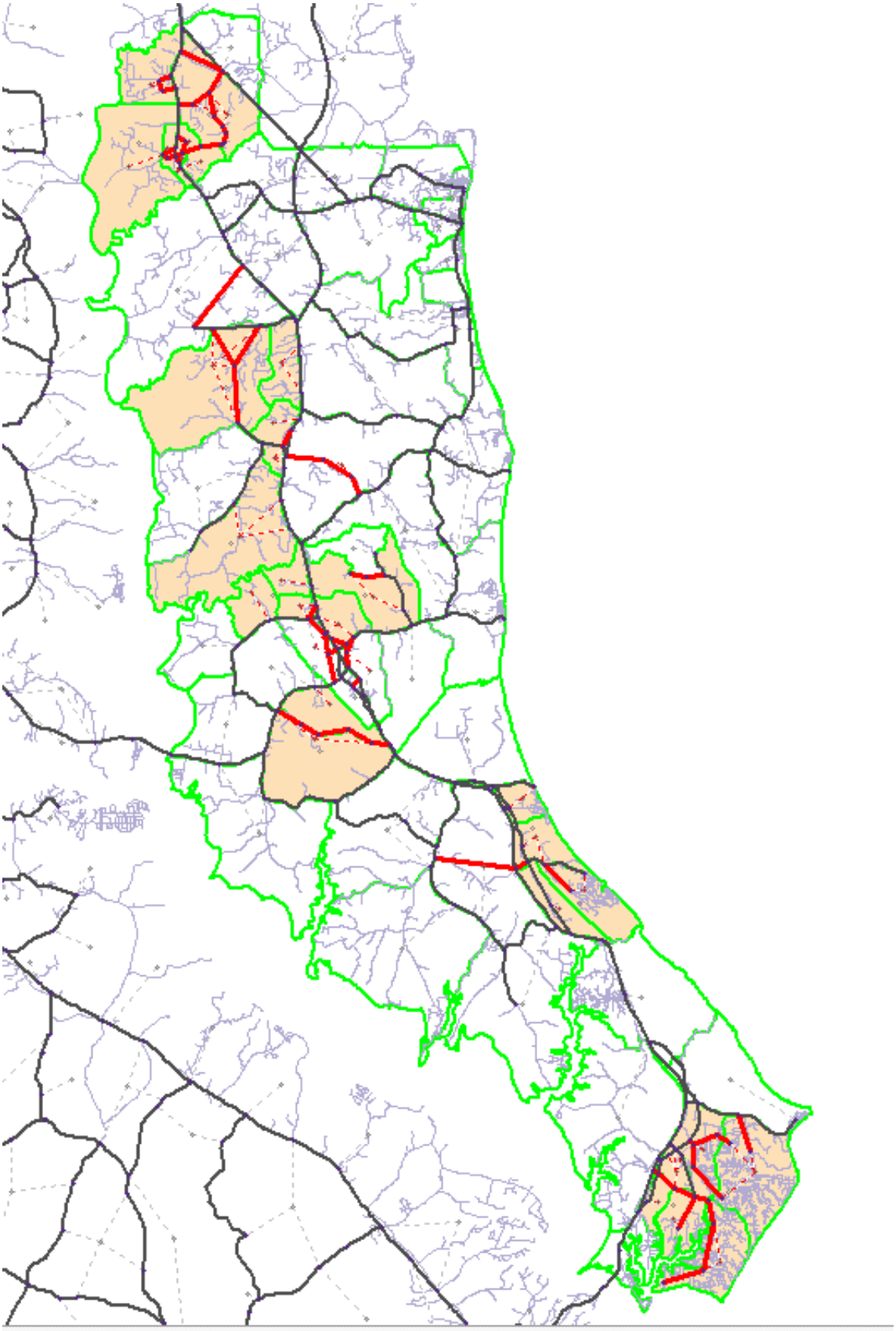

Figure 5. Red lines show the additional roadway links added to the MWCOG model. Additional detail can be found in Appendix

Land Use Plans & Growth Scenarios

The MWCOG Round 9.1 Cooperative Land Use Forecast (CLUF) was the baseline land use scenario for the travel demand forecast. The CLUF was refined by Department of Planning & Zoning to reflect the detailed zoning currently allowed in the town centers, local environmental conditions and growth management programs which constrain the amount of growth that can occur. Census information, detailed parcel data and current zoning were used to relate the CLUF to the split TAZs in order to yield baseline and future population, household and employment.

Using the higher level of land use detail and development capacity as applied to smaller TAZs, population, households and jobs were modeled to a 2040 horizon year using the town center boundaries in the 2019 comprehensive plan update. Population and employment were calculated as a function of households. Population was calculated by assigning 2.85 persons to each non-group household. Employment in Calvert County was calculated by adding the expected jobs relative to new households to the existing conditions total employment. The household to job ratio is fixed at 1:1, with 35% of all new jobs located in Calvert County (per 2018 LODES data). Geographic distribution of population, households and employment in 2040 is shown in Figures 6 – 8, respectively.

Scenario 1: Historical Growth

This scenario uses household growth rate between 2010 and 2017 as reported by the United States Census to project household growth until 2040. Based on these seven years, households can be expected to increase by 12.5% by 2040 to a total population of 101,737. This rate is slightly higher than the forecast by the Maryland Department of Planning which projects 100,450 residents by 2040.[3]

Scenario 2: Aggressive Growth

This scenario projects significantly a 50% growth in households throughout the county through 2040. This growth rate resembles market conditions like the period from the mid-1980s through 2010. During this time period, the county population increased from approximately 34,000 to approximately 88,000 residents.

Scenario 3: Hyper Growth

The scenario projects a maximum build-out by 2040 of all developable residential parcels even when including environmental constraints and growth management programs such as transferable development rates currently in place. A 91.8% household occupancy rate was applied to all buildable residential parcels. This would add approximately 75,000+ residents to Calvert County beyond the population forecast in scenario #1 (historical growth rate).

		2040 Horizon Year		
	2017 Baseline	**Scenario #1: Historical Growth**	**Scenario #2: Aggressive Growth**	**Scenario #3: Hyper Growth**
Households	33,064	35,198	50,642	61,478
Population	93,228	101,737	145,752	176,636
Employment	35,120	35,562	40,784	53,222

Table 1. Baseline and Forecast Household, Population and Employment Data.

[3] See county-by-county population projections at https://planning.maryland.gov/MSDC/Documents/popproj/TotalPopProj.pdf For information regarding MDP's population forecasting process, see https://planning.maryland.gov/MSDC/Documents/popproj/Overview-Population-Projections-Methodology.pdf

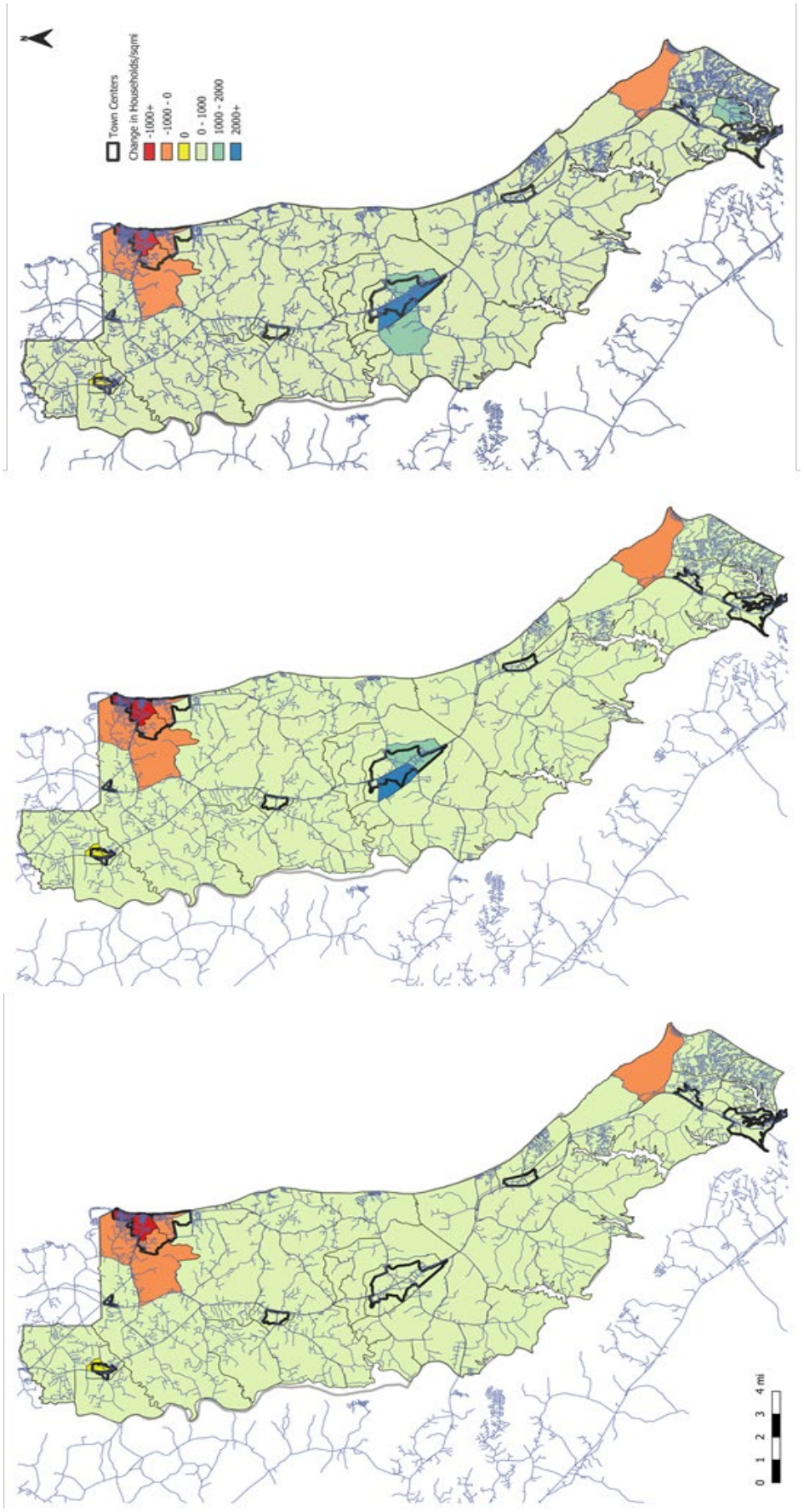

Figure 6. Change in Households by Growth Scenario

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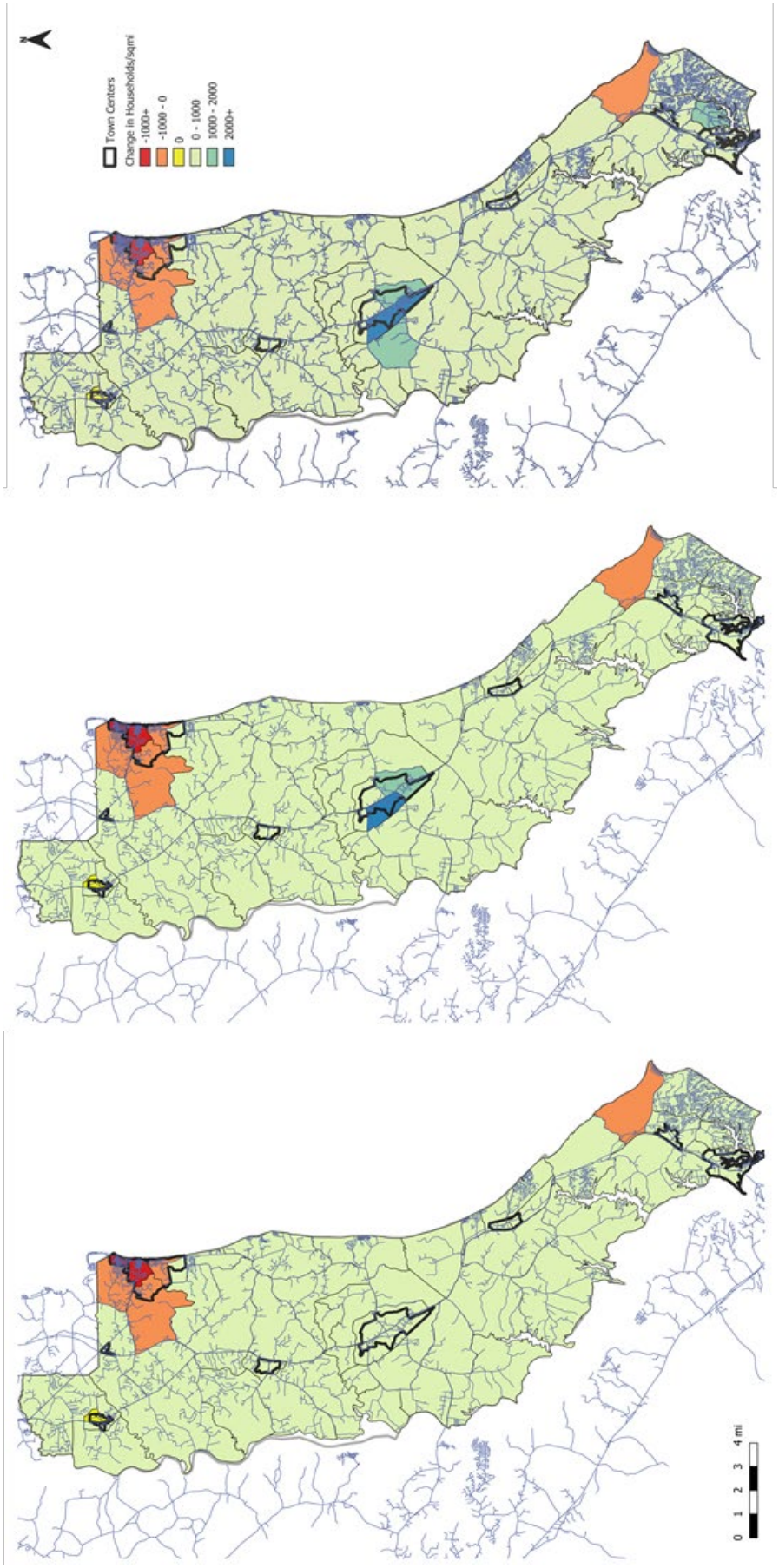

Figure 7. Change in Population by Growth Scenario

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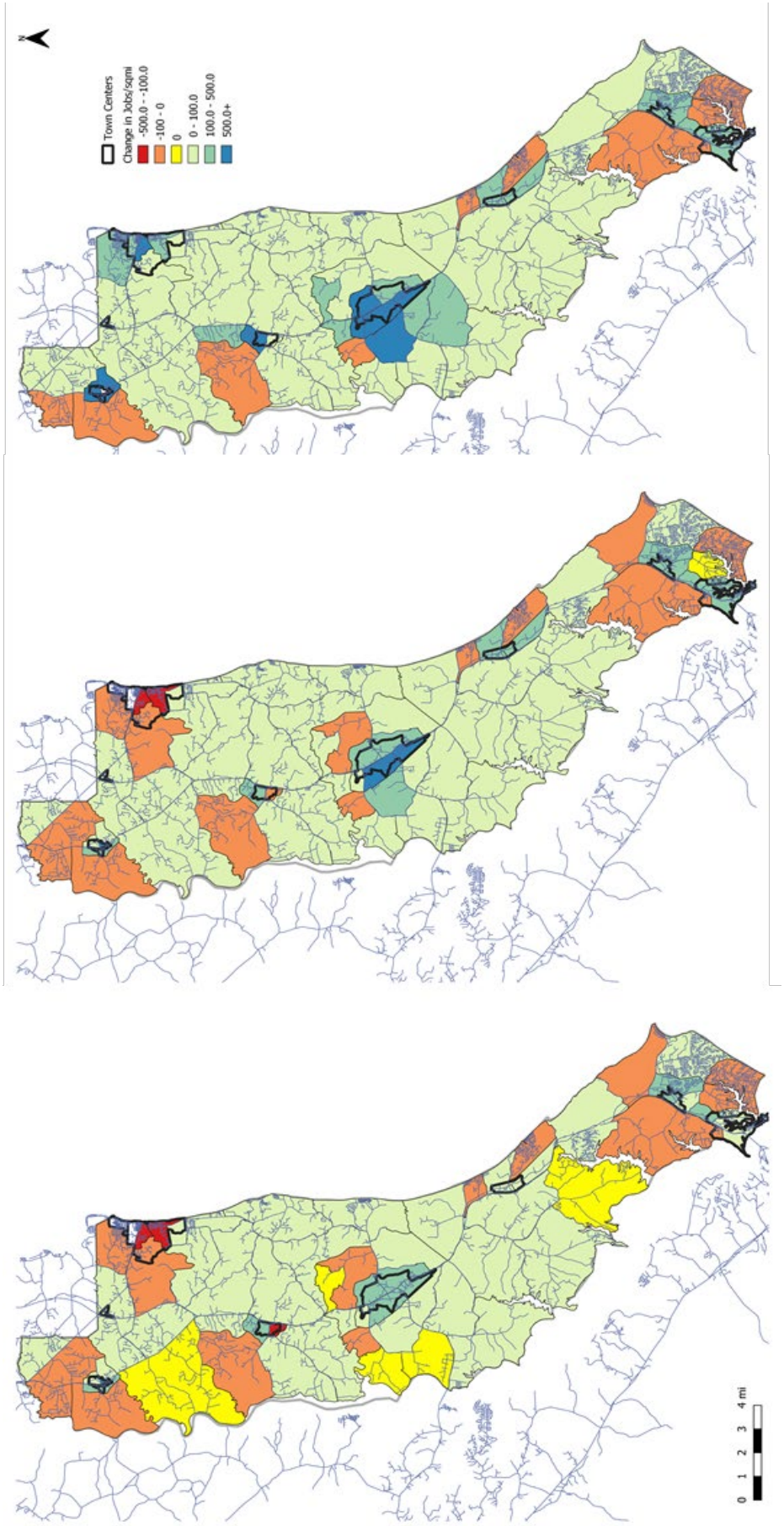

Figure 8. Change in Employment by Growth Scenario

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Travel Forecasting Outputs

Travel forecasts were carried out using the refined TAZs, additional road network details and growth scenarios described above. Key model outputs are described below. Additional assessments on *how* these volumes impact the AM and PM peak period congestion at various locations within the road system are part of a more detailed operational analysis (Level of Service, Volume to Capacity Ratio, etc.) and are shown in the Appendix. Potential mitigation measures for congested areas are also identified in the Appendix, however, the selection of specific mitigation measures should generally be left to the Town Center planning process.

Table 2 provides a summary of the different forecasts and the Average Annual Weekday Vehicle trips (AAWDT) from, to, and within Calvert County that for each growth scenario. The forecast ranges from the 2017 baseline of 270,335 AAWDT to 611,601 AAWDT in Scenario 3 (Maximum Household Growth)

Table 2 and the maps shown in Figures 10 - 11 also show how trips are assigned to the road network in 2017 and 2040 for all roads with volumes greater than 2,000 trips per day. (For 2040, the 2017 volumes are also overlaid so the change in volumes can be seen).

	Comparison of Calvert County Scenario Travel Forecasts (24 hour Volumes) by Scenario							
			2040					
		Calvert 2017	Historical Growth		Aggressive Growth		Hyper Growth Rate	
Loc	Desc	AAWDT	AAWDT	% diff	AAWDT	% diff	AAWDT	% diff
1	MD 4 @ Anne Arundel Co. Line	46293	51949	12.22%	54175	17.03%	62006	33.94%
2	MD 2 @ Anne Arundel Co. Line	20380	23384	14.74%	24140	18.45%	25937	27.27%
3	MD 4 @ Lyons Creek Rd	31406	35647	13.50%	37521	19.47%	48031	52.94%
4	Ward Rd @ Dunkirk	1754	1565	-10.78%	1848	5.36%	4015	128.91%
5	MD 4 @ W Mt Harmony	29464	34214	16.12%	36064	22.40%	45379	54.02%
6	MD 2/4 @ M.F. Bowen	45913	52817	15.04%	56655	23.40%	72148	57.14%
7	Stoakley Rd @ Prince Frederick Blvd	3209	3380	5.33%	4017	25.18%	6867	113.99%
8	Dares Beach Rd @ Arthur King Rd.	8357	10706	28.11%	11709	40.11%	18076	116.30%
9	Holloway Point Rd @ Prince Frederick Blvd	16387	20012	22.12%	23872	45.68%	31631	93.02%
10	MD 2/4 @ German Chapel Rd	36134	44609	23.45%	48531	34.31%	56469	56.28%
11	German Chapel Rd @ MD 2/4	1938	2337	20.59%	4549	134.73%	7939	309.65%
12	MD 231 Bridge	18243	21850	19.77%	24030	31.72%	28820	57.98%
13	MD 2/4 @ Calvert Cliffs Pkwy	35766	45049	25.95%	49053	37.15%	52995	48.17%
14	MD 497 @ Cove Pt Park	7094	8071	13.77%	9664	36.23%	10957	54.45%
15	MD 2/4 S. of Apple Lane	26290	36332	38.20%	41376	57.38%	45770	74.10%
16	MD 765 S. of Apple Lane	12595	14307	13.59%	19361	53.72%	21926	74.08%
17	MD 2/4 @ Thomas Johnson Bridge	30084	44368	47.48%	47265	57.11%	48928	62.64%

Table 2. Two Way Average Weekday Daily Traffic Forecasts By Scenario at Key Locations

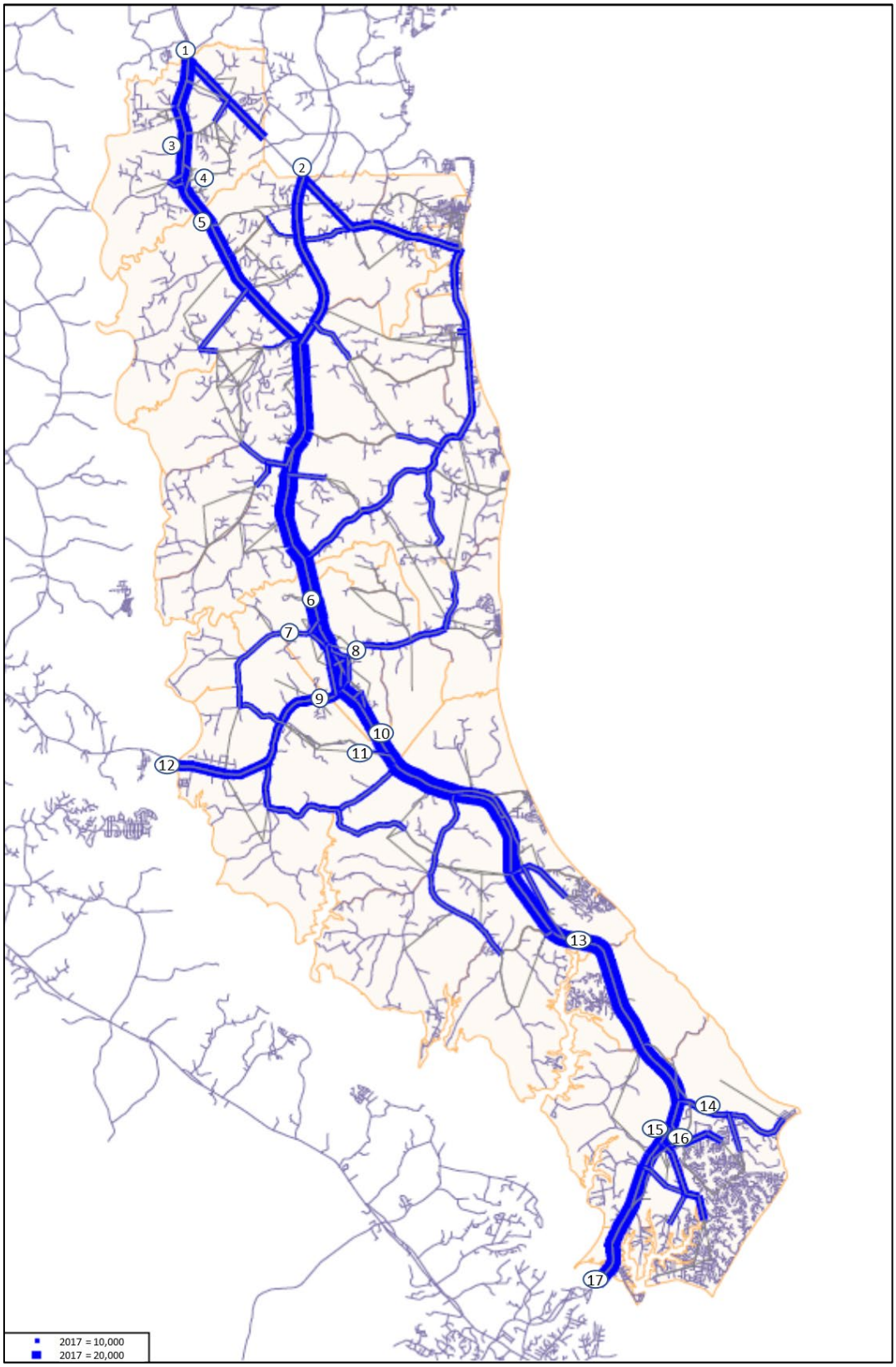


Figure 10. 2017 Average Annual Weekday Traffic plotted in bandwidth format. Location #s correspond to table above.

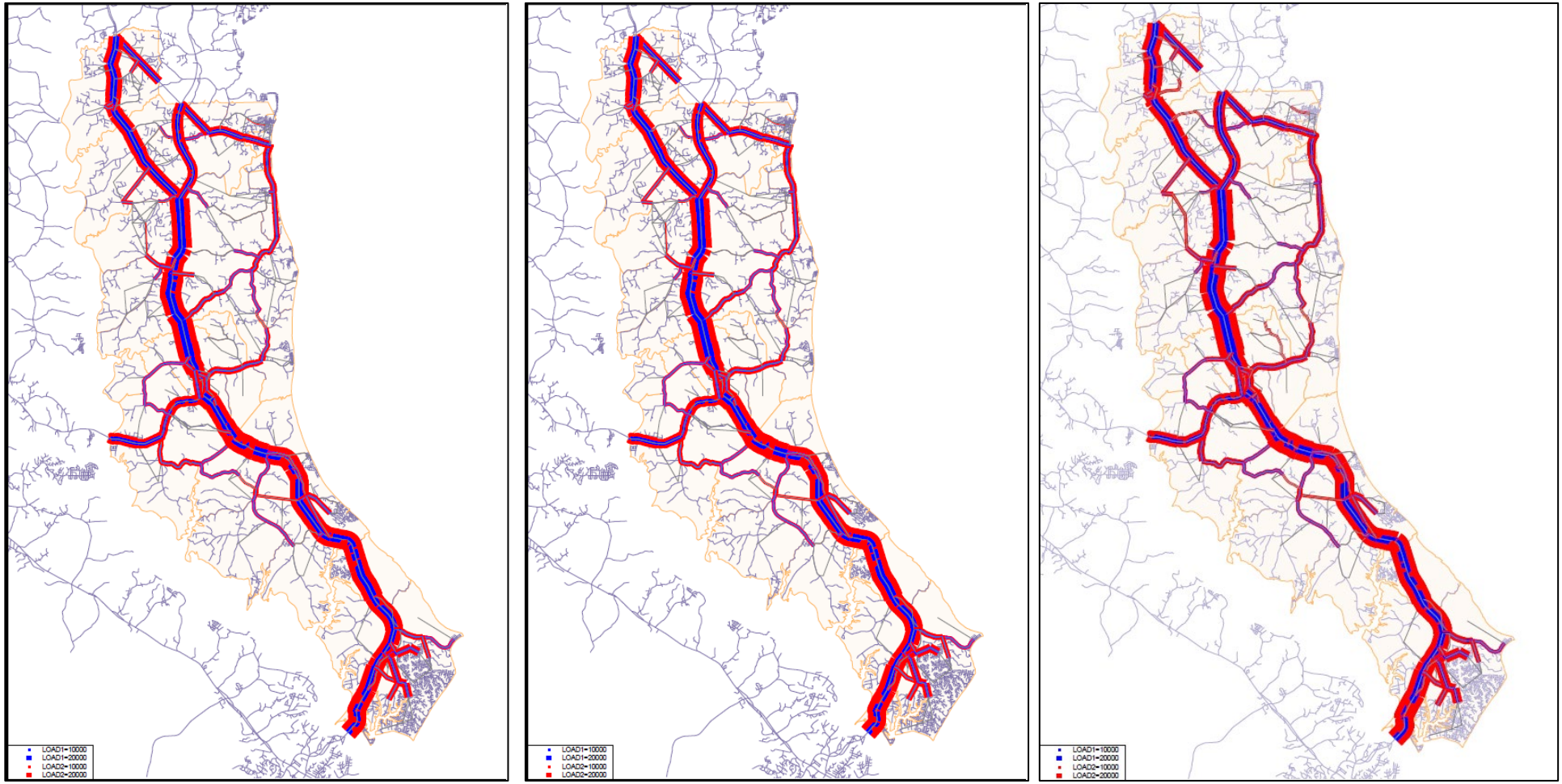


Figure 11. From left to right. 2040 Average Annual Weekday Traffic plotted in bandwidth format at the historic, aggressive and hyper growth rates. 2017 AAWDT (blue) is overlaid on the 2040 AAWDT (red) for comparative purposes.

- As can be seen in Table 3, the growth in AAWDT is not uniform throughout the County but depends on the relative location of where the trips start, where they are going, and the route used to get there. Trips entering and leaving the County grow in the north from 12% to 33% on Route 4, and 14% to 27% on Route 2; to 20% to 58% at the MD 231 bridge and 47% to 68% at the Governor Thomas Johnson Bridge.

- Table 2 also shows the two way Average Weekday Daily Traffic (AAWDT) at key entrances and exits to the County (yellow highlight) and around the Town Centers of concern along MD 2-4. These locations are also mapped in Figure 10.

- While the growth at the different locations varies significantly the overall traffic patterns found in the growth scenarios are very similar. Table 3 summarizes how these volumes impact the overall performance of the transportation network.

- While the Directional Route Miles is essentially the same in 2017 and 2040, the Vehicle Miles Traveled (VMT) on the network increases from 1,866,800 in 2017 to 2,918,800 in Scenario 3 (Hyper Growth). In the most likely forecast, Scenario 1 (Historical Growth Rate), VMT grows to 2,242,100.

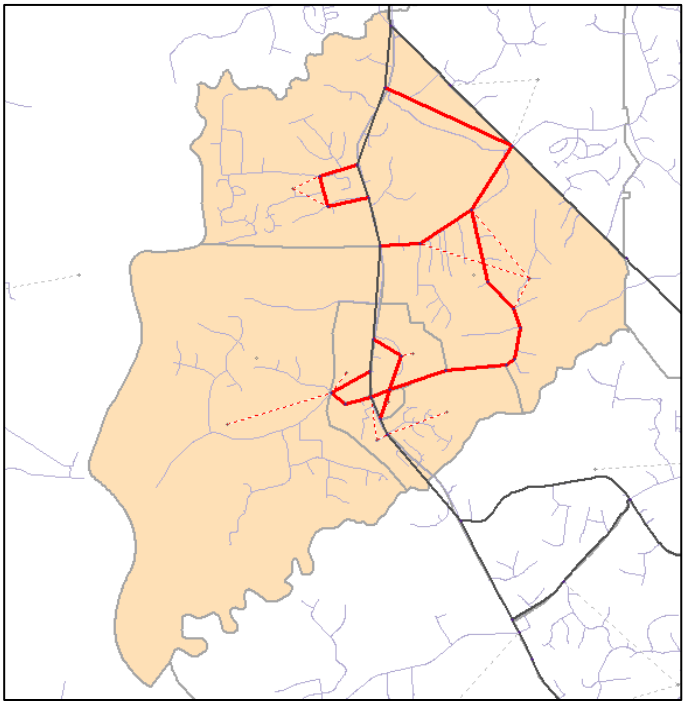
- Notwithstanding the increase in VMT relative to the very minor change in directional route miles, 82% of the roadway network is forecast to have low to some congestion (V/C lower than 0.79) under Scenario 1 (Historical Growth Rate). The percent of the network with a V/C above 1 is only 2.33% at the Historical Growth Rate. Segments of MD 2-4 comprise the areas where V/C exceeds 1.

Additional assessments on how these volumes impact the AM and PM peak period congestion at various locations within the road system are part of a more detailed operational analysis (Level of Service, Volume to Capacity Ratio, etc.) and are shown in Appendices 2 and 3. Potential mitigation measures for congested areas are also identified in the Appendix, however, the selection of specific mitigation measures is generally left to the town center planning process.

Calvert County Forecast Average Weekday Vehicle Trips				
Scenario	From Calvert	To Calvert	Within Calvert	Total
2017: Base Forecast	51,187	50,784	168,364	270,335
2040: Historical Growth Rate	59,199	58,377	185,260	302,836
2040: Aggressive Growth	65,074	64,346	230,821	360,241
2040: Hyper Growth	77,189	76,174	458,237	611,600
	2017	2040		
	Base	Historic Growth	Aggressive Growth	Hyper Growth
Directional Route Miles	360	360	360	360
Lane Miles	442	449	449	449
VMT (On Network)	1,866,796	2,242,136	2,461,453	2,918,797
Directional Route Miles by Congestion Level				
Low	260.1	247.9	236.4	204.1
(V/C < 0.45)	72.27%	68.88%	65.68%	56.71%
Some	77.5	56.9	63.6	68.6
(0.45>= V/C < 0.79)	21.53%	15.81%	17.67%	19.06%
Severe	17.7	46.8	45.0	50.7
(0.79>= V/C < 1.0)	4.92%	13.00%	12.50%	14.09%
Failure	3.9	8.4	14.9	37.6
(V/C>= 1.0)	1.08%	2.33%	4.14%	10.45%
Am Peak VMT*	356,310	438,876	471,069	541,645
Am Peak VHT*	9,459	13,667	16,135	22,197
Am Peak Speed (mph)	37.7	32.1	29.2	24.4
Pm Peak Directional Route Miles by Congestion Level				
Low	260.0	242.3	228.9	199.7
(V/C < 0.45)	72.24%	67.32%	63.60%	55.49%
Some	83.9	68.8	66.4	72.4
(0.45>= V/C < 0.79)	23.31%	19.12%	18.45%	20.12%
Severe	14.0	43.8	52.0	56.0
(0.79>= V/C < 1.0)	3.89%	12.17%	14.45%	15.56%
Failure	2.1	5.0	12.5	31.9
(V/C>= 1.0)	0.58%	1.39%	3.47%	8.86%
Pm Peak VMT*	513,712	632,378	685,595	800,598
Pm Peak VHT*	13,339	18,143	21,643	31,207
Pm Peak Speed (mph)	38.5	34.9	31.7	25.7
* VMT = Vehicle Miles Traveled				
* VHT = Vehicle Hours Traveled				

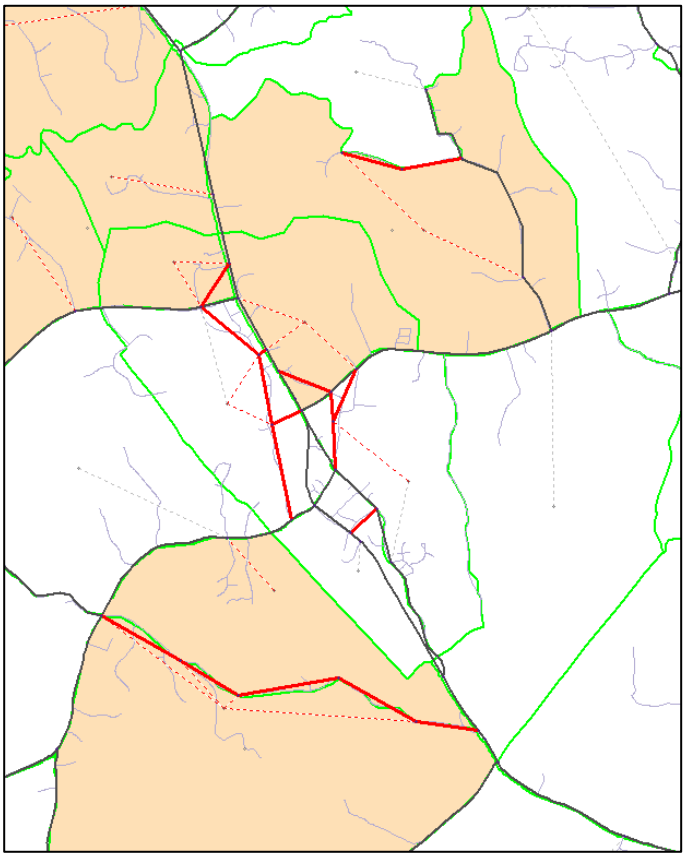
Table 3. Road Network Performance Measures for 2017 and 2040 Growth Scenarios

APPENDIX 1 – ADDITIONAL NETWORK DETAIL



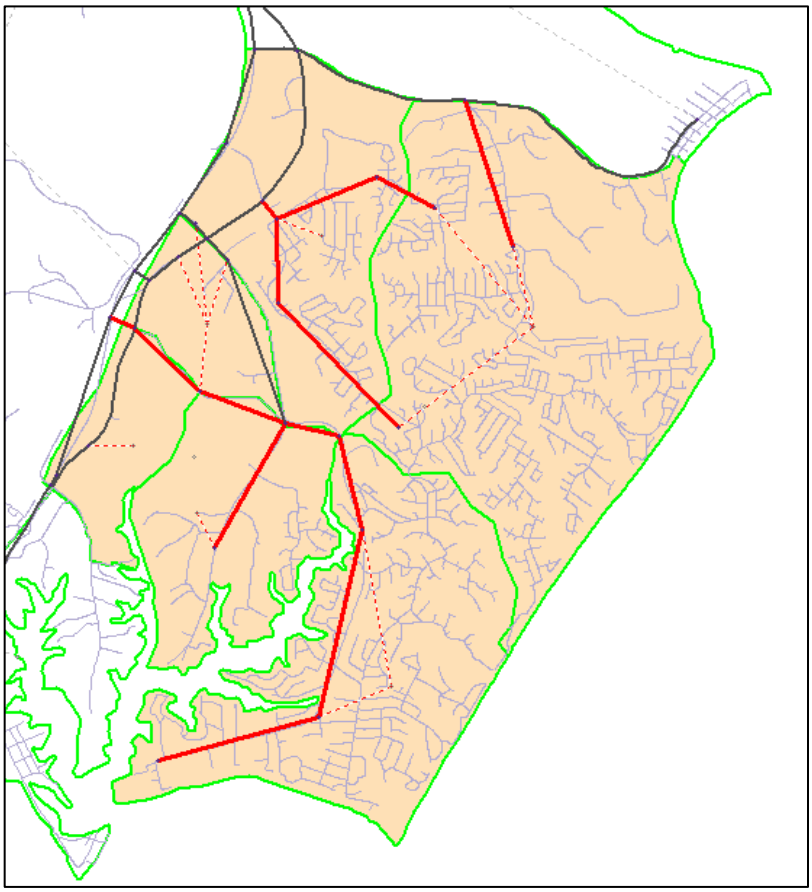
Huntingtown Area

- Briscoe Town Rd
- Mill Branch Rd
- Huntingtown Rd
- Cox Rd
- MD 521/MD 524



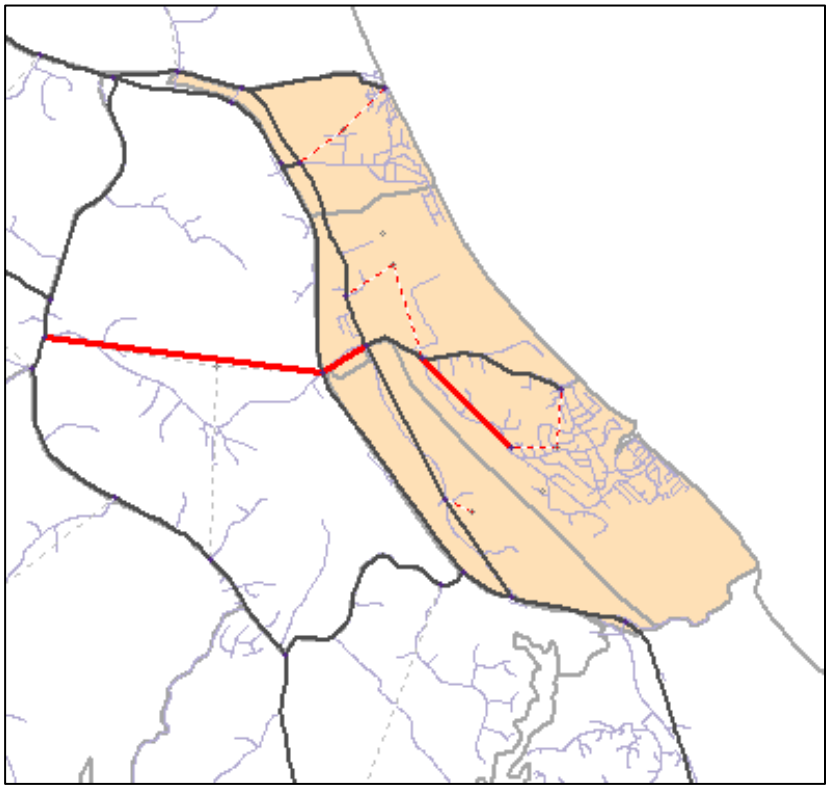
Prince Frederick Area

- N. Prince Frederick Blvd
- Dorsey Rd extended
- Armory Rd
- Fariground Rd
- Old Field Ln
- German Chapel Rd
- Fox Run Blvd.



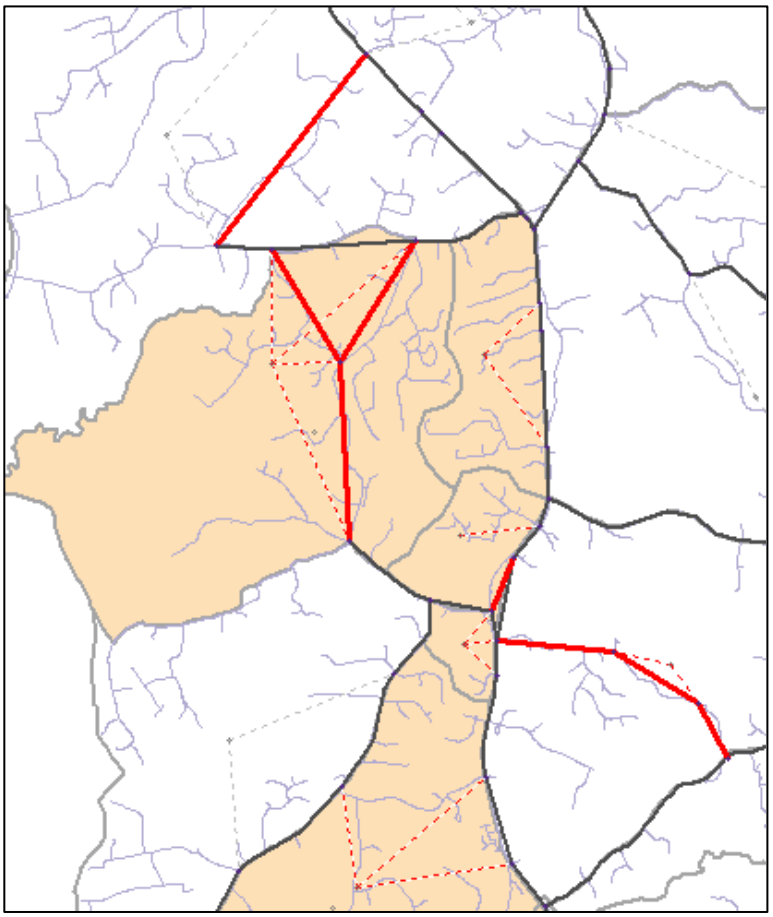
Solomons/Lusby

- MD 760 to Ship Point
- Olivet Rd extended
- Thunderbird Dr
- Gunsmoke Trail
- Little Cove Point Rd



St. Leonard Area

- Ball Rd
- Long Beach Rd



Dunkirk Area

- Jewell Rd
- Brickhouse Rd
- Ward Rd
- Dunkirk Way
- Lyons Creek Rd
- Crown Dr
- Ferry Landing Rd
- Ashwood Rd

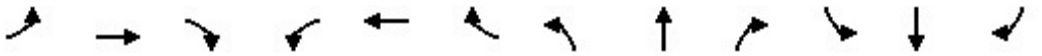
APPENDIX 2 – 2017 VOLUME-CAPACITY AND DELAY PER INTERSECTION

Intersection	Control	Approach	Existing - AM			Existing - PM		
			V/C	Delay (s)	LOS	V/C	Delay (s)	LOS
MD 4 & Ward Rd.	Signalized	Overall	0.68	26.2	C	0.86	48.3	D
		EB	0.56	46.5	D	0.68	37.3	D
		WB	0.23	65.6	E	0.88	95.4	F
		NB	0.76	23.5	C	0.58	31.2	C
		SB	0.23	16.0	B	0.93	47.3	D
MD 2-4/MD 4 & MD 2	Signalized	Overall	0.82	39.2	D	0.84	28.4	C
		WB	0.90	84.5	F	0.90	44.9	D
		NB	0.81	37.8	D	0.83	49.7	D
		SB	0.64	12.3	B	0.68	6.0	A
MD 2-4 & MD 524/COX Road	Signalized	Overall	0.86	45.8	D	1.31	217.5	F
		EB	0.70	74.6	E	0.74	77.4	E
		WB	0.50	75.7	E	0.65	81.2	F
		NB	0.93	44.6	D	1.79	227.6	F
		SB	0.64	31.0	C	1.45	247.9	F
MD 2/4 & MD 263 Plum Point Rd.	Signalized	Overall	0.78	25.3	C	0.74	16.7	B
		WB	0.92	92.2	F	0.82	82.2	F
		NB	0.68	24.5	C	0.61	19.5	B
		SB	0.71	5.8	A	0.74	4.5	A
MD 2-4 & Stoakley/Hospital	Signalized	Overall	0.75	21.3	C	0.85	46.4	D
		EB	0.67	54.9	D	0.80	84.1	F
		WB	0.29	52.7	D	0.68	82.1	F
		NB	0.84	15.1	B	0.77	34.0	C
		SB	0.62	20.4	C	0.93	43.1	D
MD 2-4 & MD 402	Signalized	Overall	0.76	27.6	C	0.85	39.7	D
		EB	0.23	48.1	D	0.74	82.8	F
		WB	0.49	42.3	D	0.66	65.2	E
		NB	0.92	30.0	C	0.69	31.4	C
		SB	0.56	16.2	B	0.96	29.4	C
MD 2-4 & MD 231/Church St.	Signalized	Overall	0.56	26.2	C	0.70	32.9	C
		EB	0.61	35.8	D	0.77	44.2	D
		WB	0.31	50.8	D	0.63	80.3	F
		NB	0.69	25.0	C	0.65	30.5	C
		SB	0.31	19.1	B	0.70	23.3	C

Intersection	Control	Approach	Existing - AM			Existing - PM		
			V/C	Delay (s)	LOS	V/C	Delay (s)	LOS
MD 508 Adelina Rd. & MD 231	Unsignalized	Overall	-	-	-	-	-	-
		EB	0.28	0.0	A	0.38	0.0	A
		WB[1]	0.33	1.2	A	0.37	9.6	A
		NB[1]	0.20	14.5	B	0.23	18.2	C
MD 2-4 & Sixes Rd.	Unsignalized	Overall	-	-	-	-	-	-
		EB[1]	1.01	185.6	F	9.60	Err	F
		NB[1]	0.60	0.2	B	0.46	0.5	E
		SB	0.28	0.0	A	0.78	0.8	A
MD 2-4 & MD 264	Signalized	Overall	0.61	11.7	B	0.73	11.6	B
		EB	0.71	39.9	D	0.73	65.9	E
		NB	0.43	1.0	A	0.34	1.1	A
		SB	0.40	17.4	B	0.69	11.1	B
MD 2/4 & Ball Rd./Calvert Beach Rd.	Signalized	Overall	0.67	23.8	C	0.78	38.6	D
		EB	0.38	52.9	D	0.56	74.2	E
		WB	0.50	18.9	B	0.76	61.3	E
		NB	0.68	23.2	C	0.60	29.8	C
		SB	0.38	20.7	C	0.78	36.1	D
MD 2-4 & MD 497 Cove Point Rd.	Signalized	Overall	0.51	12.9	B	0.72	24.7	C
		EB	0.45	20.6	C	0.00	24.3	C
		WB	0.20	22.2	C	0.45	25.8	C
		NB	0.50	13.2	B	0.70	16.6	B
		SB	0.45	8.7	A	1.12	31.8	C
MD 2-4 & Monticello Dr./Dowell Rd.	Unsignalized	Overall	-	-	-	-	-	-
		EB	0.04	19.1	C	0.04	13.2	B
		WB	0.10	12.1	B	0.22	17.9	C
		NB[1]	0.26	0.0	C	0.44	0.1	B
		SB[1]	0.55	0.4	B	0.34	1.7	C

1- These approaches are "free". The delay reported is for the main line left movements.

APPENDIX 3 – HCM DETAIL BY STUDY INTERSECTION



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	173	28	74	56	24	53	148	1670	97	21	462	67
Future Volume (vph)	173	28	74	56	24	53	148	1670	97	21	462	67
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	0.95	1.00	0.97	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.90		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1705	1583	3433	3174		3433	3539	1583	3433	3539	1583
Flt Permitted	0.95	0.96	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1705	1583	3433	3174		3433	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	180	29	77	58	25	55	154	1740	101	22	481	70
RTOR Reduction (vph)	0	0	0	0	51	0	0	0	35	0	0	28
Lane Group Flow (vph)	90	119	77	58	29	0	154	1740	66	22	481	42
Turn Type	Split	NA	Free	Split	NA		Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		1	6		5	2	
Permitted Phases			Free						6			2
Actuated Green, G (s)	15.3	15.3	150.0	8.0	8.0		12.1	95.4	95.4	4.8	88.1	88.1
Effective Green, g (s)	18.8	18.8	150.0	11.0	11.0		14.1	97.4	97.4	6.8	90.1	90.1
Actuated g/C Ratio	0.13	0.13	1.00	0.07	0.07		0.09	0.65	0.65	0.05	0.60	0.60
Clearance Time (s)	7.5	7.5		7.0	7.0		6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	210	213	1583	251	232		322	2297	1027	155	2125	950
v/s Ratio Prot	0.05	c0.07		c0.02	0.01		c0.04	c0.49		0.01	0.14	
v/s Ratio Perm			0.05						0.04			0.03
v/c Ratio	0.43	0.56	0.05	0.23	0.13		0.48	0.76	0.06	0.14	0.23	0.04
Uniform Delay, d1	60.6	61.7	0.0	65.5	65.0		64.5	18.2	9.6	68.8	13.8	12.3
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.4	3.2	0.1	0.5	0.2		1.1	2.4	0.1	0.4	0.2	0.1
Delay (s)	62.0	64.9	0.1	66.0	65.2		65.6	20.5	9.7	69.2	14.1	12.4
Level of Service	E	E	A	E	E		E	C	A	E	B	B
Approach Delay (s)		46.5			65.6			23.5			16.0	
Approach LOS		D			E			C			B	

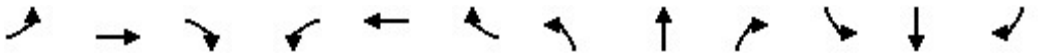
Intersection Summary			
HCM 2000 Control Delay	26.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	75.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	418	54	1502	500	79	615
Future Volume (vph)	418	54	1502	500	79	615
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	4.0	7.0	7.0	5.5	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	3539	1583	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	3539	1583	1770	3539
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	445	57	1598	532	84	654
RTOR Reduction (vph)	0	0	0	230	0	0
Lane Group Flow (vph)	445	57	1598	302	84	654
Turn Type	Prot	Free	NA	Perm	Prot	NA
Protected Phases	4!		2		1	Free!
Permitted Phases		Free		2		
Actuated Green, G (s)	60.3	215.4	120.5	120.5	16.1	215.4
Effective Green, g (s)	60.3	215.4	120.5	120.5	16.1	215.4
Actuated g/C Ratio	0.28	1.00	0.56	0.56	0.07	1.00
Clearance Time (s)	6.0		7.0	7.0	5.5	
Vehicle Extension (s)	6.0		8.0	8.0	4.0	
Lane Grp Cap (vph)	495	1583	1979	885	132	3539
v/s Ratio Prot	c0.25		c0.45		c0.05	0.18
v/s Ratio Perm		0.04		0.19		
v/c Ratio	0.90	0.04	0.81	0.34	0.64	0.18
Uniform Delay, d1	74.6	0.0	38.1	25.8	96.8	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	20.7	0.0	3.3	1.0	10.8	0.1
Delay (s)	95.3	0.0	41.4	26.8	107.6	0.1
Level of Service	F	A	D	C	F	A
Approach Delay (s)	84.5		37.8			12.3
Approach LOS	F		D			B

Intersection Summary			
HCM 2000 Control Delay	39.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	215.4	Sum of lost time (s)	18.5
Intersection Capacity Utilization	86.8%	ICU Level of Service	E
Analysis Period (min)	15		

! Phase conflict between lane groups.
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	230	33	137	19	22	234	123	1692	17	66	1099	34
Future Volume (vph)	230	33	137	19	22	234	123	1692	17	66	1099	34
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0		6.0	6.0	6.0	8.0	8.0	6.0	8.0	8.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1706	1583		1820	1583	1770	3539	1583	1770	3539	1583
Flt Permitted	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1706	1583		1820	1583	1770	3539	1583	1770	3539	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	253	36	151	21	24	257	135	1859	19	73	1208	37
RTOR Reduction (vph)	0	0	133	0	0	195	0	0	8	0	0	17
Lane Group Flow (vph)	144	145	18	0	45	62	135	1859	11	73	1208	20
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		1	6		5	2	
Permitted Phases			4			3			6			2
Actuated Green, G (s)	20.2	20.2	20.2		12.9	12.9	17.3	93.3	93.3	12.6	88.6	88.6
Effective Green, g (s)	20.2	20.2	20.2		12.9	12.9	17.3	93.3	93.3	12.6	88.6	88.6
Actuated g/C Ratio	0.12	0.12	0.12		0.08	0.08	0.10	0.57	0.57	0.08	0.54	0.54
Clearance Time (s)	6.0	6.0	6.0		6.0	6.0	6.0	8.0	8.0	6.0	8.0	8.0
Vehicle Extension (s)	3.5	3.5	3.5		3.0	3.0	3.5	6.0	6.0	3.5	6.0	6.0
Lane Grp Cap (vph)	205	208	193		142	123	185	2001	895	135	1900	850
v/s Ratio Prot	c0.09	0.09			0.02		c0.08	c0.53		0.04	0.34	
v/s Ratio Perm			0.01			c0.04			0.01			0.01
v/c Ratio	0.70	0.70	0.10		0.32	0.50	0.73	0.93	0.01	0.54	0.64	0.02
Uniform Delay, d1	69.5	69.5	64.3		71.9	73.0	71.6	32.8	15.7	73.4	26.9	17.9
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	10.7	10.1	0.3		1.3	3.2	13.9	9.2	0.0	4.8	1.6	0.1
Delay (s)	80.3	79.6	64.5		73.2	76.1	85.4	42.0	15.7	78.3	28.5	18.0
Level of Service	F	E	E		E	E	F	D	B	E	C	B
Approach Delay (s)		74.6			75.7			44.6			31.0	
Approach LOS		E			E			D			C	

Intersection Summary			
HCM 2000 Control Delay	45.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	165.0	Sum of lost time (s)	26.0
Intersection Capacity Utilization	85.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	321	66	1424	177	66	1200
Future Volume (vph)	321	66	1424	177	66	1200
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	8.0	8.0	11.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	3539	1583	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	3539	1583	1770	3539
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	331	68	1468	182	68	1237
RTOR Reduction (vph)	0	46	0	49	0	0
Lane Group Flow (vph)	331	22	1468	133	68	1237
Turn Type	Prot	Perm	NA	Perm	Prot	NA
Protected Phases	4!		2 9		1	Free!
Permitted Phases		4		2 9		
Actuated Green, G (s)	37.5	37.5	111.9	111.9	10.0	183.4
Effective Green, g (s)	37.5	37.5	111.9	111.9	10.0	183.4
Actuated g/C Ratio	0.20	0.20	0.61	0.61	0.05	1.00
Clearance Time (s)	5.0	5.0			11.0	
Vehicle Extension (s)	4.0	4.0			3.5	
Lane Grp Cap (vph)	361	323	2159	965	96	3539
v/s Ratio Prot	c0.19		c0.41		0.04	0.35
v/s Ratio Perm		0.01		0.08		
v/c Ratio	0.92	0.07	0.68	0.14	0.71	0.35
Uniform Delay, d1	71.4	58.8	23.8	15.2	85.3	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	27.6	0.1	1.7	0.3	21.9	0.3
Delay (s)	99.1	59.0	25.6	15.5	107.1	0.3
Level of Service	F	E	C	B	F	A
Approach Delay (s)	92.2		24.5			5.8
Approach LOS	F		C			A

Intersection Summary			
HCM 2000 Control Delay	25.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	183.4	Sum of lost time (s)	32.0
Intersection Capacity Utilization	80.1%	ICU Level of Service	D
Analysis Period (min)	15		

! Phase conflict between lane groups.
c Critical Lane Group

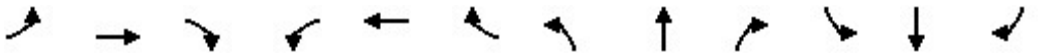
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL
Lane Configurations												
Traffic Volume (vph)	224	37	43	68	5	1	17	92	1433	239	48	142
Future Volume (vph)	224	37	43	68	5	1	17	92	1433	239	48	142
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	5.0		3.0	3.0	3.0		3.0
Lane Util. Factor	0.95	0.95	1.00	0.95	0.95	1.00		0.97	0.95	1.00		1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00	0.85		1.00
Flt Protected	0.95	0.97	1.00	0.95	0.96	1.00		0.95	1.00	1.00		0.95
Satd. Flow (prot)	1681	1708	1583	1681	1695	1583		3433	3539	1583		1770
Flt Permitted	0.95	0.97	1.00	0.95	0.96	1.00		0.95	1.00	1.00		0.95
Satd. Flow (perm)	1681	1708	1583	1681	1695	1583		3433	3539	1583		1770
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	243	40	47	74	5	1	18	100	1558	260	52	154
RTOR Reduction (vph)	0	0	41	0	0	1	0	0	0	123	0	0
Lane Group Flow (vph)	141	142	6	39	40	0	0	118	1558	137	0	206
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	Prot	NA	Perm	Prot	Prot
Protected Phases	3	3		4	4		1	1	6		5	5
Permitted Phases			3			4				6		
Actuated Green, G (s)	12.0	12.0	12.0	6.8	6.8	6.8		8.5	58.0	58.0		17.2
Effective Green, g (s)	15.0	15.0	15.0	9.8	9.8	7.8		11.5	63.0	63.0		20.2
Actuated g/C Ratio	0.12	0.12	0.12	0.08	0.08	0.06		0.10	0.52	0.52		0.17
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0		6.0	8.0	8.0		6.0
Vehicle Extension (s)	2.0	2.0	2.0	2.5	2.5	2.5		2.0	5.0	5.0		2.0
Lane Grp Cap (vph)	210	213	197	137	138	102		328	1857	831		297
v/s Ratio Prot	c0.08	0.08		0.02	c0.02			0.03	c0.44			c0.12
v/s Ratio Perm			0.00			0.00				0.09		
v/c Ratio	0.67	0.67	0.03	0.28	0.29	0.00		0.36	0.84	0.17		0.69
Uniform Delay, d1	50.1	50.1	46.1	51.8	51.8	52.5		50.8	24.2	14.8		47.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.21	0.39	0.28		1.00
Incremental Delay, d2	6.5	6.0	0.0	0.8	0.8	0.0		0.2	3.7	0.3		5.6
Delay (s)	56.6	56.1	46.1	52.6	52.7	52.5		61.7	13.3	4.4		52.6
Level of Service	E	E	D	D	D	D		E	B	A		D
Approach Delay (s)		54.9			52.7				15.1			
Approach LOS		D			D				B			

Intersection Summary			
HCM 2000 Control Delay	21.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	78.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	1197	184
Future Volume (vph)	1197	184
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	3.0	3.0
Lane Util. Factor	0.95	1.00
Frt	1.00	0.85
Flt Protected	1.00	1.00
Satd. Flow (prot)	3539	1583
Flt Permitted	1.00	1.00
Satd. Flow (perm)	3539	1583
Peak-hour factor, PHF	0.92	0.92
Adj. Flow (vph)	1301	200
RTOR Reduction (vph)	0	81
Lane Group Flow (vph)	1301	120
Turn Type	NA	Perm
Protected Phases	2	
Permitted Phases		2
Actuated Green, G (s)	66.7	66.7
Effective Green, g (s)	71.7	71.7
Actuated g/C Ratio	0.60	0.60
Clearance Time (s)	8.0	8.0
Vehicle Extension (s)	5.0	5.0
Lane Grp Cap (vph)	2114	945
v/s Ratio Prot	0.37	
v/s Ratio Perm		0.08
v/c Ratio	0.62	0.13
Uniform Delay, d1	15.4	10.5
Progression Factor	1.00	1.00
Incremental Delay, d2	1.4	0.3
Delay (s)	16.7	10.8
Level of Service	B	B
Approach Delay (s)	20.4	
Approach LOS	C	

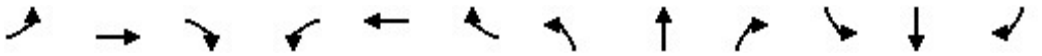
Intersection Summary



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	55	27	90	169	74	192	70	1668	210	117	1092	67
Future Volume (vph)	55	27	90	169	74	192	70	1668	210	117	1092	67
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	5.0	3.0	3.0	5.0	4.0	3.0	3.0	4.0	3.0	3.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	1863	1583	1770	1863	1583	1770	3539	1583	1770	3539	1583
Flt Permitted	0.71	1.00	1.00	0.58	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1318	1863	1583	1084	1863	1583	1770	3539	1583	1770	3539	1583
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	57	28	93	174	76	198	72	1720	216	121	1126	69
RTOR Reduction (vph)	0	0	85	0	0	170	0	0	67	0	0	30
Lane Group Flow (vph)	57	28	8	174	76	28	72	1720	149	121	1126	39
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4		3	8		1	6		5	2	
Permitted Phases	4		4	8		8			6			2
Actuated Green, G (s)	16.0	9.1	9.1	27.8	15.9	15.9	9.0	60.2	60.2	13.5	64.7	64.7
Effective Green, g (s)	20.0	12.1	10.1	29.8	18.9	16.9	11.0	63.7	63.7	15.5	68.2	68.2
Actuated g/C Ratio	0.17	0.10	0.08	0.25	0.16	0.14	0.09	0.53	0.53	0.13	0.57	0.57
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0	6.0	6.0	6.5	6.5	6.0	6.5	6.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	253	187	133	358	293	222	162	1878	840	228	2011	899
v/s Ratio Prot	0.02	0.02		c0.06	0.04		0.04	c0.49		c0.07	0.32	
v/s Ratio Perm	0.02		0.00	c0.06		0.02			0.09			0.02
v/c Ratio	0.23	0.15	0.06	0.49	0.26	0.13	0.44	0.92	0.18	0.53	0.56	0.04
Uniform Delay, d1	43.1	49.3	50.6	37.6	44.4	45.1	51.6	25.7	14.6	48.8	16.4	11.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.36	0.90	0.46	1.17	0.66	1.00
Incremental Delay, d2	0.2	0.1	0.1	0.4	0.2	0.1	1.8	8.1	0.4	2.0	0.9	0.1
Delay (s)	43.2	49.4	50.6	38.0	44.6	45.2	71.9	31.1	7.1	59.3	11.8	11.5
Level of Service	D	D	D	D	D	D	E	C	A	E	B	B
Approach Delay (s)		48.1			42.3			30.0			16.1	
Approach LOS		D			D			C			B	

Intersection Summary			
HCM 2000 Control Delay	27.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	351	129	145	46	85	21	369	1329	134	48	673	333
Future Volume (vph)	351	129	145	46	85	21	369	1329	134	48	673	333
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	1.0	4.0	4.0		4.0	3.0	5.5	4.0	3.0	5.5
Lane Util. Factor	0.97	1.00	1.00	0.91	0.91		0.97	0.91	1.00	0.97	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.65	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	1863	1033	1610	3287		3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	1863	1033	1610	3287		3433	5085	1583	3433	5085	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	369	136	153	48	89	22	388	1399	141	51	708	351
RTOR Reduction (vph)	0	0	0	0	16	0	0	0	69	0	0	203
Lane Group Flow (vph)	369	136	153	43	100	0	388	1399	72	51	708	148
Confl. Peds. (#/hr)	381		1477									
Confl. Bikes (#/hr)			132									
Turn Type	Split	NA	Free	Split	NA		Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		1	6		5	2	
Permitted Phases			Free						6			2
Actuated Green, G (s)	18.3	18.3	120.0	8.9	8.9		17.6	60.4	60.4	6.9	49.7	49.7
Effective Green, g (s)	21.3	21.3	120.0	11.9	11.9		19.6	63.9	61.4	8.9	53.2	50.7
Actuated g/C Ratio	0.18	0.18	1.00	0.10	0.10		0.16	0.53	0.51	0.07	0.44	0.42
Clearance Time (s)	6.0	6.0		7.0	7.0		6.0	6.5	6.5	6.0	6.5	6.5
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	5.0	5.0	4.0	5.0	5.0
Lane Grp Cap (vph)	609	330	1033	159	325		560	2707	809	254	2254	668
v/s Ratio Prot	c0.11	0.07		0.03	c0.03		c0.11	c0.28		0.01	0.14	
v/s Ratio Perm			0.15						0.05			0.09
v/c Ratio	0.61	0.41	0.15	0.27	0.31		0.69	0.52	0.09	0.20	0.31	0.22
Uniform Delay, d1	45.5	43.8	0.0	50.0	50.2		47.4	18.1	15.0	52.2	21.6	22.1
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.15	0.56	1.17
Incremental Delay, d2	1.7	0.8	0.3	0.9	0.5		3.7	0.7	0.2	0.5	0.3	0.7
Delay (s)	47.2	44.6	0.3	51.0	50.8		51.1	18.8	15.2	60.5	12.4	26.6
Level of Service	D	D	A	D	D		D	B	B	E	B	C
Approach Delay (s)		35.8			50.8			25.0			19.1	
Approach LOS		D			D			C			B	

Intersection Summary			
HCM 2000 Control Delay	26.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	454	11	83	525	17	111
Future Volume (Veh/h)	454	11	83	525	17	111
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	478	12	87	553	18	117
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						8
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			490		1205	478
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			490		1205	478
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			92		90	80
cM capacity (veh/h)			1073		187	587

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	478	12	87	553	135
Volume Left	0	0	87	0	18
Volume Right	0	12	0	0	117
cSH	1700	1700	1073	1700	678
Volume to Capacity	0.28	0.01	0.08	0.33	0.20
Queue Length 95th (ft)	0	0	7	0	18
Control Delay (s)	0.0	0.0	8.6	0.0	14.5
Lane LOS			A		B
Approach Delay (s)	0.0		1.2		14.5
Approach LOS					B

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	41.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	40	41	36	1885	861	19
Future Volume (Veh/h)	40	41	36	1885	861	19
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	43	45	39	2049	936	21
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2038	468	957			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2038	468	957			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	7	92	95			
cM capacity (veh/h)	46	542	714			

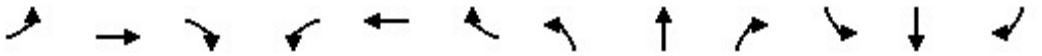
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	88	39	1024	1024	468	468	21
Volume Left	43	39	0	0	0	0	0
Volume Right	45	0	0	0	0	0	21
cSH	87	714	1700	1700	1700	1700	1700
Volume to Capacity	1.01	0.05	0.60	0.60	0.28	0.28	0.01
Queue Length 95th (ft)	145	4	0	0	0	0	0
Control Delay (s)	185.6	10.3	0.0	0.0	0.0	0.0	0.0
Lane LOS	F	B					
Approach Delay (s)	185.6	0.2			0.0		
Approach LOS	F						

Intersection Summary			
Average Delay	5.3		
Intersection Capacity Utilization	63.5%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	382	10	13	1443	693	98
Future Volume (vph)	382	10	13	1443	693	98
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.5	5.0	4.0	6.0	6.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	1770	3539	3539	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	402	11	14	1519	729	103
RTOR Reduction (vph)	0	3	0	0	0	49
Lane Group Flow (vph)	402	8	14	1519	729	54
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4!		1	Free!	2 9	
Permitted Phases		4				2 9
Actuated Green, G (s)	38.6	38.6	2.8	120.5	62.6	62.6
Effective Green, g (s)	38.6	38.6	2.8	120.5	62.6	62.6
Actuated g/C Ratio	0.32	0.32	0.02	1.00	0.52	0.52
Clearance Time (s)	5.5	5.5	5.0			
Vehicle Extension (s)	3.0	3.0	3.0			
Lane Grp Cap (vph)	566	507	41	3539	1838	822
v/s Ratio Prot	c0.23		0.01	0.43	0.21	
v/s Ratio Perm		0.01				0.03
v/c Ratio	0.71	0.02	0.34	0.43	0.40	0.07
Uniform Delay, d1	36.0	28.0	57.9	0.0	17.5	14.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	4.2	0.0	4.9	0.4	0.3	0.1
Delay (s)	40.2	28.0	62.9	0.4	17.8	14.5
Level of Service	D	C	E	A	B	B
Approach Delay (s)	39.9			1.0	17.4	
Approach LOS	D			A	B	

Intersection Summary			
HCM 2000 Control Delay	11.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	120.5	Sum of lost time (s)	22.5
Intersection Capacity Utilization	69.0%	ICU Level of Service	C
Analysis Period (min)	15		

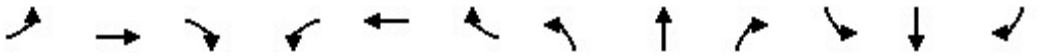
! Phase conflict between lane groups.
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	36	28	85	87	20	197	42	1223	54	14	632	6
Future Volume (vph)	36	28	85	87	20	197	42	1223	54	14	632	6
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		7.0	7.0		7.0	4.0	5.0	8.0	8.0	5.0	8.0	8.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1811	1583		1790	1583	1770	3539	1583	1770	3539	1583
Flt Permitted		0.97	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1811	1583		1790	1583	1770	3539	1583	1770	3539	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	38	29	89	92	21	207	44	1287	57	15	665	6
RTOR Reduction (vph)	0	0	80	0	0	0	0	0	26	0	0	3
Lane Group Flow (vph)	0	67	9	0	113	207	44	1287	31	15	665	3
Turn Type	Split	NA	Perm	Split	NA	Free	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2 9		1	6 9	
Permitted Phases			4			Free			2 9			6 9
Actuated Green, G (s)		12.1	12.1		15.7	124.9	7.7	66.9	66.9	3.2	62.4	62.4
Effective Green, g (s)		12.1	12.1		15.7	124.9	7.7	66.9	66.9	3.2	62.4	62.4
Actuated g/C Ratio		0.10	0.10		0.13	1.00	0.06	0.54	0.54	0.03	0.50	0.50
Clearance Time (s)		7.0	7.0		7.0		5.0			5.0		
Vehicle Extension (s)		4.0	4.0		4.0		3.0			5.0		
Lane Grp Cap (vph)		175	153		225	1583	109	1895	847	45	1768	790
v/s Ratio Prot		c0.04			c0.06		c0.02	c0.36		0.01	0.19	
v/s Ratio Perm			0.01			0.13			0.02			0.00
v/c Ratio		0.38	0.06		0.50	0.13	0.40	0.68	0.04	0.33	0.38	0.00
Uniform Delay, d1		52.9	51.2		51.0	0.0	56.4	21.2	13.7	59.8	19.3	15.7
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		1.9	0.2		2.4	0.2	2.4	1.3	0.0	8.9	0.4	0.0
Delay (s)		54.8	51.4		53.3	0.2	58.8	22.5	13.8	68.7	19.6	15.7
Level of Service		D	D		D	A	E	C	B	E	B	B
Approach Delay (s)		52.9			18.9			23.2			20.7	
Approach LOS		D			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	23.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	124.9	Sum of lost time (s)	35.0
Intersection Capacity Utilization	59.9%	ICU Level of Service	B
Analysis Period (min)	15		

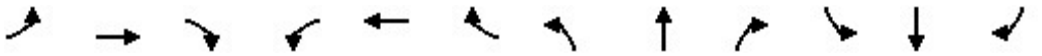
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	1	105	0	293	0	700	30	44	869	1
Future Volume (vph)	0	0	1	105	0	293	0	700	30	44	869	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			7.0	7.0		7.0		8.0	8.0	5.0	8.0	8.0
Lane Util. Factor			1.00	1.00		1.00		0.95	1.00	1.00	0.95	1.00
Frt			0.85	1.00		0.85		1.00	0.85	1.00	1.00	0.85
Flt Protected			1.00	0.95		1.00		1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)			1583	1770		1583		3539	1583	1770	3539	1583
Flt Permitted			1.00	0.76		1.00		1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)			1583	1410		1583		3539	1583	1770	3539	1583
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	1	112	0	312	0	745	32	47	924	1
RTOR Reduction (vph)	0	0	1	0	0	257	0	0	18	0	0	0
Lane Group Flow (vph)	0	0	0	112	0	55	0	745	14	47	924	1
Turn Type	Perm		Perm	Perm		Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases		4			8		1	6		5	2	
Permitted Phases	4		4	8		8			6			2
Actuated Green, G (s)			10.6	10.6		10.6		25.6	25.6	4.3	34.9	34.9
Effective Green, g (s)			10.6	10.6		10.6		25.6	25.6	4.3	34.9	34.9
Actuated g/C Ratio			0.18	0.18		0.18		0.42	0.42	0.07	0.58	0.58
Clearance Time (s)			7.0	7.0		7.0		8.0	8.0	5.0	8.0	8.0
Vehicle Extension (s)			3.0	3.0		3.0		5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)			277	247		277		1497	669	125	2041	913
v/s Ratio Prot								c0.21		0.03	c0.26	
v/s Ratio Perm			0.00	c0.08		0.03			0.01			0.00
v/c Ratio			0.00	0.45		0.20		0.50	0.02	0.38	0.45	0.00
Uniform Delay, d1			20.6	22.4		21.3		12.8	10.2	26.8	7.3	5.4
Progression Factor			1.00	1.00		1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2			0.0	1.3		0.4		0.5	0.0	1.9	0.3	0.0
Delay (s)			20.6	23.7		21.7		13.3	10.2	28.7	7.7	5.4
Level of Service			C	C		C		B	B	C	A	A
Approach Delay (s)		20.6			22.2			13.2			8.7	
Approach LOS		C			C			B			A	

Intersection Summary			
HCM 2000 Control Delay	12.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	60.5	Sum of lost time (s)	20.0
Intersection Capacity Utilization	55.7%	ICU Level of Service	B
Analysis Period (min)	15		

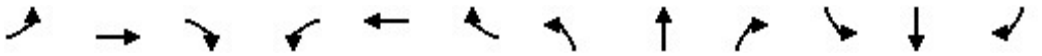
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	11	0	0	53	2	820	31	65	1737	6
Future Volume (Veh/h)	0	0	11	0	0	53	2	820	31	65	1737	6
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	0	12	0	0	57	2	882	33	70	1868	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								Raised			Raised	
Median storage veh)								1			1	
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2453	2927	934	1972	2900	441	1874			915		
vC1, stage 1 conf vol	2008	2008		886	886							
vC2, stage 2 conf vol	445	919		1086	2014							
vCu, unblocked vol	2453	2927	934	1972	2900	441	1874			915		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)	6.5	5.5		6.5	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	96	100	100	90	99			91		
cM capacity (veh/h)	47	68	267	123	70	564	317			741		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	NB 3	NB 4	SB 1	SB 2	SB 3	SB 4
Volume Total	12	57	2	441	441	33	70	934	934	6
Volume Left	0	0	2	0	0	0	70	0	0	0
Volume Right	12	57	0	0	0	33	0	0	0	6
cSH	267	564	317	1700	1700	1700	741	1700	1700	1700
Volume to Capacity	0.04	0.10	0.01	0.26	0.26	0.02	0.09	0.55	0.55	0.00
Queue Length 95th (ft)	4	8	0	0	0	0	8	0	0	0
Control Delay (s)	19.1	12.1	16.4	0.0	0.0	0.0	10.4	0.0	0.0	0.0
Lane LOS	C	B	C				B			
Approach Delay (s)	19.1	12.1	0.0				0.4			
Approach LOS	C	B								

Intersection Summary					
Average Delay	0.6				
Intersection Capacity Utilization	58.0%	ICU Level of Service		B	
Analysis Period (min)	15				



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	148	74	309	375	100	66	169	671	177	91	1840	164
Future Volume (vph)	148	74	309	375	100	66	169	671	177	91	1840	164
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	0.95	1.00	0.97	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1730	1583	3433	3327		3433	3539	1583	3433	3539	1583
Flt Permitted	0.95	0.98	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1730	1583	3433	3327		3433	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	154	77	322	391	104	69	176	699	184	95	1917	171
RTOR Reduction (vph)	0	0	0	0	57	0	0	0	68	0	0	41
Lane Group Flow (vph)	89	142	322	391	116	0	176	699	116	95	1917	130
Turn Type	Split	NA	Free	Split	NA		Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		1	6		5	2	
Permitted Phases			Free						6			2
Actuated Green, G (s)	20.7	20.7	200.0	22.5	22.5		15.6	118.9	118.9	10.9	114.2	114.2
Effective Green, g (s)	24.2	24.2	200.0	26.0	26.0		17.6	120.9	120.9	12.9	116.2	116.2
Actuated g/C Ratio	0.12	0.12	1.00	0.13	0.13		0.09	0.60	0.60	0.06	0.58	0.58
Clearance Time (s)	7.5	7.5		7.5	7.5		6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	203	209	1583	446	432		302	2139	956	221	2056	919
v/s Ratio Prot	0.05	c0.08		c0.11	0.03		c0.05	0.20		0.03	c0.54	
v/s Ratio Perm			0.20						0.07			0.08
v/c Ratio	0.44	0.68	0.20	0.88	0.27		0.58	0.33	0.12	0.43	0.93	0.14
Uniform Delay, d1	81.6	84.2	0.0	85.4	78.4		87.7	19.5	16.9	90.0	38.3	19.1
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.5	8.5	0.3	17.3	0.3		2.9	0.4	0.3	1.3	9.3	0.3
Delay (s)	83.1	92.7	0.3	102.7	78.8		90.5	19.9	17.1	91.4	47.6	19.4
Level of Service	F	F	A	F	E		F	B	B	F	D	B
Approach Delay (s)		37.3			95.4			31.2			47.3	
Approach LOS		D			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	48.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	200.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	88.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	90	119	77	58	80	154	1740	101	22	481	70
v/c Ratio	0.43	0.56	0.05	0.23	0.28	0.48	0.74	0.09	0.10	0.23	0.07
Control Delay	66.2	71.3	0.1	68.0	28.1	69.1	20.8	1.1	66.9	14.9	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	66.2	71.3	0.1	68.0	28.1	69.1	20.8	1.1	66.9	14.9	0.1
Queue Length 50th (ft)	86	116	0	27	12	74	627	0	10	110	0
Queue Length 95th (ft)	144	185	0	52	41	111	780	14	26	159	0
Internal Link Dist (ft)		420			670		920			1029	
Turn Bay Length (ft)	250		150	350		250		200	375		
Base Capacity (vph)	257	261	1583	251	283	457	2355	1095	457	2127	1001
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.35	0.46	0.05	0.23	0.28	0.34	0.74	0.09	0.05	0.23	0.07

Intersection Summary

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	445	57	1598	532	84	654
v/c Ratio	0.90	0.04	0.81	0.48	0.64	0.18
Control Delay	96.5	0.0	44.1	3.6	120.1	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	96.5	0.0	44.1	3.6	120.1	0.1
Queue Length 50th (ft)	616	0	982	6	120	0
Queue Length 95th (ft)	793	0	1195	72	197	0
Internal Link Dist (ft)	670		1020			780
Turn Bay Length (ft)		430		600	550	
Base Capacity (vph)	577	1583	1979	1115	169	3539
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.77	0.04	0.81	0.48	0.50	0.18

Intersection Summary

Lane Group	EBL	EBT	EBR	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	144	145	151	45	257	135	1859	19	73	1208	37
v/c Ratio	0.70	0.69	0.46	0.32	0.81	0.73	0.93	0.02	0.54	0.64	0.04
Control Delay	86.7	86.1	13.1	75.5	34.6	93.2	42.7	0.1	87.3	31.2	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	86.7	86.1	13.1	75.5	34.6	93.2	42.7	0.1	87.3	31.2	0.1
Queue Length 50th (ft)	160	161	0	48	48	143	912	0	77	465	0
Queue Length 95th (ft)	234	236	67	87	146	220	#1402	0	132	691	0
Internal Link Dist (ft)		598		772			1042			1670	
Turn Bay Length (ft)	165		165		60	570		370			300
Base Capacity (vph)	220	223	338	330	461	216	2000	937	214	1899	895
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.65	0.65	0.45	0.14	0.56	0.63	0.93	0.02	0.34	0.64	0.04

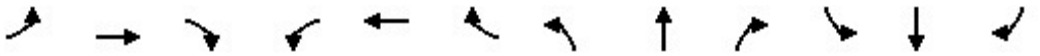
Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	331	68	1468	182	68	1237
v/c Ratio	0.92	0.18	0.68	0.18	0.71	0.35
Control Delay	101.4	18.2	26.1	5.5	121.5	0.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	101.4	18.2	26.1	5.5	121.5	0.3
Queue Length 50th (ft)	404	10	623	27	85	0
Queue Length 95th (ft)	#588	58	701	64	#173	0
Internal Link Dist (ft)	970		808			1049
Turn Bay Length (ft)		265		250	220	
Base Capacity (vph)	387	391	2157	1014	96	3539
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.86	0.17	0.68	0.18	0.71	0.35

Intersection Summary

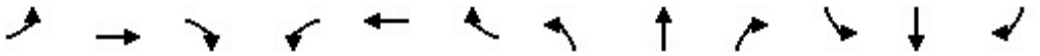
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	141	142	47	39	40	1	118	1558	260	206	1301	200
v/c Ratio	0.67	0.67	0.14	0.26	0.26	0.00	0.36	0.82	0.27	0.69	0.61	0.19
Control Delay	66.8	66.2	0.9	54.3	54.4	0.0	63.4	13.9	1.1	59.7	17.4	2.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	66.8	66.2	0.9	54.3	54.4	0.0	63.4	13.9	1.1	59.7	17.4	2.2
Queue Length 50th (ft)	111	112	0	30	30	0	48	134	0	149	325	0
Queue Length 95th (ft)	#200	#198	0	66	67	0	m75	#555	21	235	445	34
Internal Link Dist (ft)		432			432			1346			1420	
Turn Bay Length (ft)				250			225		325	300		600
Base Capacity (vph)	210	213	333	245	247	339	500	1894	967	303	2149	1040
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.67	0.67	0.14	0.16	0.16	0.00	0.24	0.82	0.27	0.68	0.61	0.19

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	57	28	93	174	76	198	72	1720	216	121	1126	69
v/c Ratio	0.21	0.16	0.38	0.49	0.26	0.51	0.39	0.90	0.24	0.53	0.54	0.07
Control Delay	36.1	52.6	7.8	41.9	47.9	11.3	73.1	31.0	3.4	63.6	12.0	0.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	36.1	52.6	7.8	41.9	47.9	11.3	73.1	31.0	3.4	63.6	12.0	0.9
Queue Length 50th (ft)	34	20	0	112	53	0	59	654	8	101	121	0
Queue Length 95th (ft)	68	50	22	174	101	69	108	#906	20	165	186	m3
Internal Link Dist (ft)		672			672			395			1495	
Turn Bay Length (ft)	200		225	250		250	350			250		350
Base Capacity (vph)	382	271	319	375	300	398	280	1908	919	267	2076	981
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.15	0.10	0.29	0.46	0.25	0.50	0.26	0.90	0.24	0.45	0.54	0.07

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	369	136	153	43	116	388	1399	141	51	708	351
v/c Ratio	0.61	0.41	0.15	0.27	0.34	0.69	0.51	0.16	0.18	0.31	0.40
Control Delay	49.5	46.9	0.3	53.6	44.6	54.2	19.8	3.5	59.3	13.1	4.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	49.5	46.9	0.3	53.6	44.6	54.2	19.8	3.5	59.3	13.1	4.6
Queue Length 50th (ft)	137	95	0	34	39	145	252	0	17	86	19
Queue Length 95th (ft)	178	149	0	73	69	201	349	36	m30	150	98
Internal Link Dist (ft)		1058			270		444			576	
Turn Bay Length (ft)	650		400	250		400		350	400		350
Base Capacity (vph)	772	419	1033	188	402	591	2759	895	572	2254	871
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.48	0.32	0.15	0.23	0.29	0.66	0.51	0.16	0.09	0.31	0.40

Intersection Summary

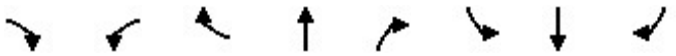
m Volume for 95th percentile queue is metered by upstream signal.

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	402	11	14	1519	729	103
v/c Ratio	0.69	0.02	0.14	0.43	0.39	0.12
Control Delay	42.9	24.4	59.4	0.4	17.6	3.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	42.9	24.4	59.4	0.4	17.6	3.4
Queue Length 50th (ft)	240	3	9	0	137	0
Queue Length 95th (ft)	434	19	34	0	246	29
Internal Link Dist (ft)	750			609	251	
Turn Bay Length (ft)		125	460			
Base Capacity (vph)	614	552	379	3539	2124	991
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.65	0.02	0.04	0.43	0.34	0.10

Intersection Summary

Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	67	89	113	207	44	1287	57	15	665	6
v/c Ratio	0.38	0.32	0.50	0.13	0.31	0.67	0.06	0.11	0.38	0.01
Control Delay	67.0	4.7	64.1	0.2	69.2	23.1	1.1	68.2	21.1	0.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	67.0	4.7	64.1	0.2	69.2	23.1	1.1	68.2	21.1	0.0
Queue Length 50th (ft)	46	0	76	0	31	322	0	10	173	0
Queue Length 95th (ft)	127	9	190	0	94	606	9	44	267	0
Internal Link Dist (ft)	953		883			1750			738	
Turn Bay Length (ft)		135		300	460		530	560		485
Base Capacity (vph)	390	447	386	1583	458	2358	1083	458	2352	1081
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.17	0.20	0.29	0.13	0.10	0.55	0.05	0.03	0.28	0.01

Intersection Summary



Lane Group	EBR	WBL	WBR	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	1	112	312	745	32	47	924	1
v/c Ratio	0.00	0.44	0.57	0.48	0.04	0.19	0.47	0.00
Control Delay	0.0	28.8	7.6	14.9	0.1	28.0	8.8	0.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	0.0	28.8	7.6	14.9	0.1	28.0	8.8	0.0
Queue Length 50th (ft)	0	40	0	111	0	17	87	0
Queue Length 95th (ft)	0	82	55	180	0	47	152	0
Internal Link Dist (ft)				1526			1584	
Turn Bay Length (ft)		290	315		560	1000		500
Base Capacity (vph)	641	382	662	1548	773	248	1969	944
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.00	0.29	0.47	0.48	0.04	0.19	0.47	0.00

Intersection Summary

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	89	142	322	391	173	176	699	184	95	1917	171
v/c Ratio	0.44	0.68	0.20	0.88	0.35	0.58	0.33	0.18	0.43	0.93	0.18
Control Delay	87.7	100.2	0.3	105.6	51.2	95.3	20.6	3.3	95.5	47.9	9.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	87.7	100.2	0.3	105.6	51.2	95.3	20.6	3.3	95.5	47.9	9.4
Queue Length 50th (ft)	115	191	0	265	68	117	235	6	63	1203	42
Queue Length 95th (ft)	185	278	0	#355	113	160	300	46	97	#1494	92
Internal Link Dist (ft)		420			670		920			1029	
Turn Bay Length (ft)	250		150	350		250		200	375		
Base Capacity (vph)	235	242	1583	446	489	411	2139	1024	411	2057	961
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.38	0.59	0.20	0.88	0.35	0.43	0.33	0.18	0.23	0.93	0.18

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	698	90	844	689	169	1858
v/c Ratio	0.90	0.06	0.83	0.73	0.68	0.53
Control Delay	52.3	0.1	57.1	8.3	73.1	0.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	52.3	0.1	57.1	8.3	73.1	0.6
Queue Length 50th (ft)	583	0	410	0	157	0
Queue Length 95th (ft)	#888	0	#571	124	242	0
Internal Link Dist (ft)	670		1020			780
Turn Bay Length (ft)		430		600	550	
Base Capacity (vph)	887	1583	1014	945	386	3539
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.79	0.06	0.83	0.73	0.44	0.53

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBL	EBT	EBR	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	170	174	309	105	78	451	2088	46	412	2490	62
v/c Ratio	0.74	0.73	0.67	0.66	0.35	1.79	1.29	0.06	1.36	1.45	0.08
Control Delay	92.5	91.5	17.3	97.9	13.6	410.4	176.3	0.9	234.1	241.5	3.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	92.5	91.5	17.3	97.9	13.6	410.4	176.3	0.9	234.1	241.5	3.0
Queue Length 50th (ft)	201	205	26	119	0	~776	~1611	0	~623	~2053	0
Queue Length 95th (ft)	306	311	135	201	43	#1121	#1984	5	#950	#2458	19
Internal Link Dist (ft)		598		772			1042			1670	
Turn Bay Length (ft)	165		165		60	570		370			300
Base Capacity (vph)	335	345	543	364	388	252	1613	764	302	1714	807
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.51	0.50	0.57	0.29	0.20	1.79	1.29	0.06	1.36	1.45	0.08

Intersection Summary

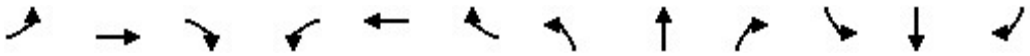
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	254	53	1371	427	73	1972
v/c Ratio	0.82	0.17	0.61	0.38	0.74	0.56
Control Delay	92.1	14.5	21.6	5.0	121.2	0.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	92.1	14.5	21.6	5.0	121.2	0.6
Queue Length 50th (ft)	295	0	490	50	87	0
Queue Length 95th (ft)	404	43	627	122	#191	0
Internal Link Dist (ft)	970		808			1049
Turn Bay Length (ft)		265		250	220	
Base Capacity (vph)	399	398	2239	1117	99	3539
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.64	0.13	0.61	0.38	0.74	0.56

Intersection Summary

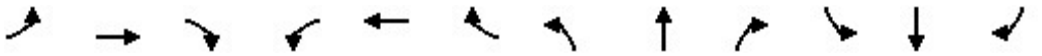
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	199	200	133	146	149	2	176	1615	87	58	1871	272
v/c Ratio	0.80	0.80	0.39	0.68	0.67	0.01	0.57	0.77	0.09	0.45	0.93	0.27
Control Delay	97.2	97.1	14.6	89.7	89.5	0.0	95.6	31.0	3.4	89.6	46.1	2.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	97.2	97.1	14.6	89.7	89.5	0.0	95.6	31.0	3.4	89.6	46.1	2.9
Queue Length 50th (ft)	240	241	7	175	180	0	108	1005	9	67	1085	0
Queue Length 95th (ft)	344	345	74	255	260	0	155	1109	13	119	#1390	50
Internal Link Dist (ft)		432			432			1346			1420	
Turn Bay Length (ft)				250			225		325	300		600
Base Capacity (vph)	275	277	364	275	280	329	352	2109	980	181	2005	1014
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.72	0.72	0.37	0.53	0.53	0.01	0.50	0.77	0.09	0.32	0.93	0.27

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	142	112	342	208	108	101	150	1416	114	110	1915	144
v/c Ratio	0.46	0.54	0.89	0.65	0.41	0.34	0.69	0.69	0.12	0.61	0.96	0.16
Control Delay	58.3	86.2	46.2	65.6	75.7	14.9	96.1	27.8	5.7	107.2	28.4	2.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	58.3	86.2	46.2	65.6	75.7	14.9	96.1	27.8	5.7	107.2	28.4	2.5
Queue Length 50th (ft)	134	126	111	205	116	0	176	574	3	130	962	8
Queue Length 95th (ft)	204	#228	#338	293	192	63	m252	740	m44	m149	#1392	m13
Internal Link Dist (ft)		672			672			395			1495	
Turn Bay Length (ft)	200		225	250		250	350			250		350
Base Capacity (vph)	408	206	383	363	266	296	265	2056	955	265	1987	928
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.35	0.54	0.89	0.57	0.41	0.34	0.57	0.69	0.12	0.42	0.96	0.16

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	404	134	414	114	232	256	1026	76	67	1937	463
v/c Ratio	0.77	0.47	0.26	0.63	0.61	0.65	0.34	0.08	0.30	0.70	0.48
Control Delay	83.8	75.2	0.4	91.9	78.7	83.8	19.8	1.6	86.6	23.3	9.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	83.8	75.2	0.4	91.9	78.7	83.8	19.8	1.6	86.6	23.3	9.1
Queue Length 50th (ft)	237	145	0	142	137	151	228	0	41	391	69
Queue Length 95th (ft)	301	222	0	225	189	198	276	16	m51	m517	m94
Internal Link Dist (ft)		1058			270		444			576	
Turn Bay Length (ft)	650		400	250		400		350	400		350
Base Capacity (vph)	553	300	1583	205	429	610	3006	954	610	2757	957
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.73	0.45	0.26	0.56	0.54	0.42	0.34	0.08	0.11	0.70	0.48

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	182	16	12	899	1762	413
v/c Ratio	0.71	0.07	0.14	0.25	0.68	0.34
Control Delay	72.1	26.7	70.7	0.2	12.8	4.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	72.1	26.7	70.7	0.2	12.8	4.4
Queue Length 50th (ft)	150	2	10	0	309	38
Queue Length 95th (ft)	255	25	36	0	683	131
Internal Link Dist (ft)	750			609	251	
Turn Bay Length (ft)		125	460			
Base Capacity (vph)	529	483	327	3539	2605	1221
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.34	0.03	0.04	0.25	0.68	0.34

Intersection Summary

Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	92	123	185	70	89	891	87	81	1477	44
v/c Ratio	0.57	0.47	0.77	0.04	0.61	0.48	0.10	0.51	0.79	0.05
Control Delay	90.5	13.9	93.3	0.0	94.9	27.4	4.3	87.7	36.6	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	90.5	13.9	93.3	0.0	94.9	27.4	4.3	87.7	36.6	0.1
Queue Length 50th (ft)	104	0	208	0	102	332	0	91	698	0
Queue Length 95th (ft)	176	55	#346	0	172	445	33	158	908	0
Internal Link Dist (ft)	953		883			1750			738	
Turn Bay Length (ft)		135		300	460		530	560		485
Base Capacity (vph)	274	352	270	1583	319	1786	842	319	1880	881
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.34	0.35	0.69	0.04	0.28	0.50	0.10	0.25	0.79	0.05

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBT	WBL	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	1	95	163	1	1069	146	235	1110	2
v/c Ratio	0.00	0.42	0.33	0.00	0.76	0.20	1.05	0.56	0.00
Control Delay	21.0	29.9	1.9	26.0	21.5	3.7	106.1	12.3	0.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	21.0	29.9	1.9	26.0	21.5	3.7	106.1	12.3	0.0
Queue Length 50th (ft)	0	33	0	0	176	0	~99	109	0
Queue Length 95th (ft)	4	73	2	4	275	32	#238	#304	0
Internal Link Dist (ft)	237				1526			1584	
Turn Bay Length (ft)		290	315	1000		560	1000		500
Base Capacity (vph)	458	346	600	224	1403	715	224	1995	955
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.00	0.27	0.27	0.00	0.76	0.20	1.05	0.56	0.00

Intersection Summary

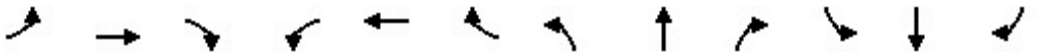
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	677	87	819	668	164	1802
Future Volume (vph)	677	87	819	668	164	1802
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	4.0	7.0	7.0	5.5	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	3539	1583	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	3539	1583	1770	3539
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	698	90	844	689	169	1858
RTOR Reduction (vph)	0	0	0	491	0	0
Lane Group Flow (vph)	698	90	844	198	169	1858
Turn Type	Prot	Free	NA	Perm	Prot	NA
Protected Phases	4!		2		1	Free!
Permitted Phases		Free		2		
Actuated Green, G (s)	62.1	141.0	40.5	40.5	19.9	141.0
Effective Green, g (s)	62.1	141.0	40.5	40.5	19.9	141.0
Actuated g/C Ratio	0.44	1.00	0.29	0.29	0.14	1.00
Clearance Time (s)	6.0		7.0	7.0	5.5	
Vehicle Extension (s)	6.0		8.0	8.0	4.0	
Lane Grp Cap (vph)	779	1583	1016	454	249	3539
v/s Ratio Prot	c0.39		c0.24		c0.10	0.52
v/s Ratio Perm		0.06		0.12		
v/c Ratio	0.90	0.06	0.83	0.44	0.68	0.53
Uniform Delay, d1	36.5	0.0	47.0	40.9	57.5	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	14.2	0.1	7.4	2.8	7.8	0.6
Delay (s)	50.6	0.1	54.5	43.8	65.3	0.6
Level of Service	D	A	D	D	E	A
Approach Delay (s)	44.9		49.7			6.0
Approach LOS	D		D			A

Intersection Summary			
HCM 2000 Control Delay	28.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	141.0	Sum of lost time (s)	18.5
Intersection Capacity Utilization	95.7%	ICU Level of Service	F
Analysis Period (min)	15		

! Phase conflict between lane groups.
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	221	88	278	34	60	70	406	1879	41	371	2241	56
Future Volume (vph)	221	88	278	34	60	70	406	1879	41	371	2241	56
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0		6.0	6.0	6.0	8.0	8.0	6.0	8.0	8.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1732	1583		1830	1583	1770	3539	1583	1770	3539	1583
Flt Permitted	0.95	0.98	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1732	1583		1830	1583	1770	3539	1583	1770	3539	1583
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	246	98	309	38	67	78	451	2088	46	412	2490	62
RTOR Reduction (vph)	0	0	245	0	0	71	0	0	25	0	0	32
Lane Group Flow (vph)	170	174	64	0	105	7	451	2088	21	412	2490	30
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		1	6		5	2	
Permitted Phases			4			3			6			2
Actuated Green, G (s)	24.1	24.1	24.1		15.5	15.5	25.1	80.3	80.3	30.1	85.3	85.3
Effective Green, g (s)	24.1	24.1	24.1		15.5	15.5	25.1	80.3	80.3	30.1	85.3	85.3
Actuated g/C Ratio	0.14	0.14	0.14		0.09	0.09	0.14	0.46	0.46	0.17	0.48	0.48
Clearance Time (s)	6.0	6.0	6.0		6.0	6.0	6.0	8.0	8.0	6.0	8.0	8.0
Vehicle Extension (s)	3.5	3.5	3.5		3.0	3.0	3.5	6.0	6.0	3.5	6.0	6.0
Lane Grp Cap (vph)	230	237	216		161	139	252	1614	722	302	1715	767
v/s Ratio Prot	c0.10	0.10			c0.06		c0.25	0.59		0.23	c0.70	
v/s Ratio Perm			0.04			0.00			0.01			0.02
v/c Ratio	0.74	0.73	0.30		0.65	0.05	1.79	1.29	0.03	1.36	1.45	0.04
Uniform Delay, d1	72.9	72.9	68.3		77.6	73.5	75.5	47.9	26.4	73.0	45.4	23.8
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	12.1	11.5	0.9		9.1	0.1	370.9	136.9	0.0	183.8	206.7	0.1
Delay (s)	85.0	84.4	69.2		86.8	73.7	446.3	184.7	26.4	256.8	252.0	23.9
Level of Service	F	F	E		F	E	F	F	C	F	F	C
Approach Delay (s)		77.4			81.2			227.6			247.9	
Approach LOS		E			F			F			F	

Intersection Summary			
HCM 2000 Control Delay	217.5	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.31		
Actuated Cycle Length (s)	176.0	Sum of lost time (s)	26.0
Intersection Capacity Utilization	116.2%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	239	50	1289	401	69	1854
Future Volume (vph)	239	50	1289	401	69	1854
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	8.0	8.0	11.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	3539	1583	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	3539	1583	1770	3539
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	254	53	1371	427	73	1972
RTOR Reduction (vph)	0	44	0	116	0	0
Lane Group Flow (vph)	254	9	1371	311	73	1972
Turn Type	Prot	Perm	NA	Perm	Prot	NA
Protected Phases	4!		2 9		1	Free!
Permitted Phases		4		2 9		
Actuated Green, G (s)	31.2	31.2	112.5	112.5	10.0	177.7
Effective Green, g (s)	31.2	31.2	112.5	112.5	10.0	177.7
Actuated g/C Ratio	0.18	0.18	0.63	0.63	0.06	1.00
Clearance Time (s)	5.0	5.0			11.0	
Vehicle Extension (s)	4.0	4.0			3.5	
Lane Grp Cap (vph)	310	277	2240	1002	99	3539
v/s Ratio Prot	c0.14		c0.39		0.04	0.56
v/s Ratio Perm		0.01		0.20		
v/c Ratio	0.82	0.03	0.61	0.31	0.74	0.56
Uniform Delay, d1	70.5	60.7	19.5	14.9	82.6	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	16.1	0.1	1.2	0.8	25.3	0.6
Delay (s)	86.7	60.8	20.7	15.6	107.9	0.6
Level of Service	F	E	C	B	F	A
Approach Delay (s)	82.2		19.5			4.5
Approach LOS	F		B			A

Intersection Summary			
HCM 2000 Control Delay	16.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	177.7	Sum of lost time (s)	32.0
Intersection Capacity Utilization	77.2%	ICU Level of Service	D
Analysis Period (min)	15		

! Phase conflict between lane groups.
c Critical Lane Group

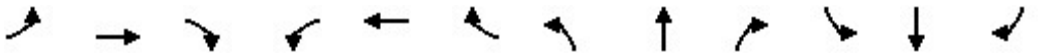
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL
Lane Configurations												
Traffic Volume (vph)	375	16	130	239	50	2	30	142	1583	85	7	50
Future Volume (vph)	375	16	130	239	50	2	30	142	1583	85	7	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	5.0		3.0	3.0	3.0		3.0
Lane Util. Factor	0.95	0.95	1.00	0.95	0.95	1.00		0.97	0.95	1.00		1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00	0.85		1.00
Flt Protected	0.95	0.96	1.00	0.95	0.97	1.00		0.95	1.00	1.00		0.95
Satd. Flow (prot)	1681	1692	1583	1681	1713	1583		3433	3539	1583		1770
Flt Permitted	0.95	0.96	1.00	0.95	0.97	1.00		0.95	1.00	1.00		0.95
Satd. Flow (perm)	1681	1692	1583	1681	1713	1583		3433	3539	1583		1770
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	383	16	133	244	51	2	31	145	1615	87	7	51
RTOR Reduction (vph)	0	0	107	0	0	2	0	0	0	36	0	0
Lane Group Flow (vph)	199	200	26	146	149	0	0	176	1615	51	0	58
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	Prot	NA	Perm	Prot	Prot
Protected Phases	3	3		4	4		1	1	6		5	5
Permitted Phases			3			4				6		
Actuated Green, G (s)	23.6	23.6	23.6	20.2	20.2	20.2		13.2	101.1	101.1		9.1
Effective Green, g (s)	26.6	26.6	26.6	23.2	23.2	21.2		16.2	106.1	106.1		12.1
Actuated g/C Ratio	0.15	0.15	0.15	0.13	0.13	0.12		0.09	0.59	0.59		0.07
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0		6.0	8.0	8.0		6.0
Vehicle Extension (s)	2.0	2.0	2.0	2.5	2.5	2.5		2.0	5.0	5.0		2.0
Lane Grp Cap (vph)	248	250	233	216	220	186		308	2086	933		118
v/s Ratio Prot	c0.12	0.12		0.09	c0.09			c0.05	0.46			0.03
v/s Ratio Perm			0.02			0.00				0.03		
v/c Ratio	0.80	0.80	0.11	0.68	0.68	0.00		0.57	0.77	0.05		0.49
Uniform Delay, d1	74.2	74.1	66.4	74.8	74.8	70.1		78.6	27.9	15.7		81.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.14	0.95	0.99		1.00
Incremental Delay, d2	16.0	15.7	0.1	7.4	7.3	0.0		1.4	2.4	0.1		1.2
Delay (s)	90.1	89.8	66.5	82.2	82.1	70.1		90.8	28.9	15.5		82.2
Level of Service	F	F	E	F	F	E		F	C	B		F
Approach Delay (s)		84.1			82.1				34.1			
Approach LOS		F			F				C			

Intersection Summary			
HCM 2000 Control Delay	46.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	1834	267
Future Volume (vph)	1834	267
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	3.0	3.0
Lane Util. Factor	0.95	1.00
Frt	1.00	0.85
Flt Protected	1.00	1.00
Satd. Flow (prot)	3539	1583
Flt Permitted	1.00	1.00
Satd. Flow (perm)	3539	1583
Peak-hour factor, PHF	0.98	0.98
Adj. Flow (vph)	1871	272
RTOR Reduction (vph)	0	118
Lane Group Flow (vph)	1871	154
Turn Type	NA	Perm
Protected Phases	2	
Permitted Phases		2
Actuated Green, G (s)	97.0	97.0
Effective Green, g (s)	102.0	102.0
Actuated g/C Ratio	0.57	0.57
Clearance Time (s)	8.0	8.0
Vehicle Extension (s)	5.0	5.0
Lane Grp Cap (vph)	2005	897
v/s Ratio Prot	c0.53	
v/s Ratio Perm		0.10
v/c Ratio	0.93	0.17
Uniform Delay, d1	35.9	18.7
Progression Factor	1.00	1.00
Incremental Delay, d2	9.5	0.4
Delay (s)	45.4	19.1
Level of Service	D	B
Approach Delay (s)	43.1	
Approach LOS	D	

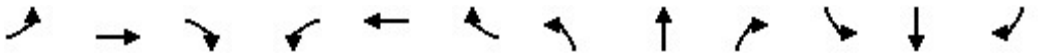
Intersection Summary



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	139	110	335	204	106	99	147	1388	112	108	1877	141
Future Volume (vph)	139	110	335	204	106	99	147	1388	112	108	1877	141
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	5.0	3.0	3.0	5.0	4.0	3.0	3.0	4.0	3.0	3.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	1863	1583	1770	1863	1583	1770	3539	1583	1770	3539	1583
Flt Permitted	0.65	1.00	1.00	0.35	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1216	1863	1583	657	1863	1583	1770	3539	1583	1770	3539	1583
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	142	112	342	208	108	101	150	1416	114	110	1915	144
RTOR Reduction (vph)	0	0	226	0	0	88	0	0	36	0	0	39
Lane Group Flow (vph)	142	112	116	208	108	13	150	1416	78	110	1915	105
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4		3	8		1	6		5	2	
Permitted Phases	4		4	8		8			6			2
Actuated Green, G (s)	33.0	16.9	16.9	43.9	22.8	22.8	20.0	101.1	101.1	16.5	97.6	97.6
Effective Green, g (s)	37.0	19.9	17.9	45.9	25.8	23.8	22.0	104.6	104.6	18.5	101.1	101.1
Actuated g/C Ratio	0.21	0.11	0.10	0.25	0.14	0.13	0.12	0.58	0.58	0.10	0.56	0.56
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0	6.0	6.0	6.5	6.5	6.0	6.5	6.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	305	205	157	315	267	209	216	2056	919	181	1987	889
v/s Ratio Prot	0.05	0.06		c0.09	0.06		c0.08	c0.40		0.06	c0.54	
v/s Ratio Perm	0.05		0.07	c0.08		0.01			0.05			0.07
v/c Ratio	0.47	0.55	0.74	0.66	0.40	0.06	0.69	0.69	0.09	0.61	0.96	0.12
Uniform Delay, d1	61.8	75.8	78.8	57.0	70.1	68.4	75.8	26.3	16.6	77.3	37.7	18.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.06	0.94	0.91	1.31	0.50	0.28
Incremental Delay, d2	0.4	1.6	14.4	4.0	0.4	0.0	9.0	1.8	0.2	2.8	8.0	0.1
Delay (s)	62.2	77.4	93.2	61.0	70.5	68.4	89.3	26.5	15.3	103.8	26.9	5.4
Level of Service	E	E	F	E	E	E	F	C	B	F	C	A
Approach Delay (s)		82.8			65.2			31.4			29.4	
Approach LOS		F			E			C			C	

Intersection Summary			
HCM 2000 Control Delay	39.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	94.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	384	127	393	126	158	45	243	975	72	64	1840	440
Future Volume (vph)	384	127	393	126	158	45	243	975	72	64	1840	440
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	1.0	4.0	4.0		4.0	3.0	5.5	4.0	3.0	5.5
Lane Util. Factor	0.97	1.00	1.00	0.91	0.91		0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	1863	1583	1610	3274		3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	1863	1583	1610	3274		3433	5085	1583	3433	5085	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	404	134	414	133	166	47	256	1026	76	67	1937	463
RTOR Reduction (vph)	0	0	0	0	12	0	0	0	32	0	0	121
Lane Group Flow (vph)	404	134	414	114	220	0	256	1026	44	67	1937	342
Turn Type	Split	NA	Free	Split	NA		Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		1	6		5	2	
Permitted Phases			Free						6			2
Actuated Green, G (s)	24.5	24.5	180.0	17.2	17.2		18.7	102.9	102.9	9.9	94.1	94.1
Effective Green, g (s)	27.5	27.5	180.0	20.2	20.2		20.7	106.4	103.9	11.9	97.6	95.1
Actuated g/C Ratio	0.15	0.15	1.00	0.11	0.11		0.11	0.59	0.58	0.07	0.54	0.53
Clearance Time (s)	6.0	6.0		7.0	7.0		6.0	6.5	6.5	6.0	6.5	6.5
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	5.0	5.0	4.0	5.0	5.0
Lane Grp Cap (vph)	524	284	1583	180	367		394	3005	913	226	2757	836
v/s Ratio Prot	c0.12	0.07		c0.07	0.07		c0.07	0.20		0.02	c0.38	
v/s Ratio Perm			0.26						0.03			0.22
v/c Ratio	0.77	0.47	0.26	0.63	0.60		0.65	0.34	0.05	0.30	0.70	0.41
Uniform Delay, d1	73.2	69.6	0.0	76.4	76.1		76.2	18.9	16.5	80.1	30.5	25.5
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.06	0.70	0.66
Incremental Delay, d2	6.9	1.2	0.4	7.1	2.8		3.7	0.3	0.1	0.7	1.0	1.0
Delay (s)	80.1	70.9	0.4	83.4	78.8		79.9	19.2	16.6	85.5	22.4	18.0
Level of Service	F	E	A	F	E		E	B	B	F	C	B
Approach Delay (s)		44.2			80.3			30.5			23.3	
Approach LOS		D			F			C			C	

Intersection Summary			
HCM 2000 Control Delay	32.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	73.1%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	595	29	116	569	13	97
Future Volume (Veh/h)	595	29	116	569	13	97
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	654	32	127	625	14	107
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						8
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			686		1533	654
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			686		1533	654
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			86		87	77
cM capacity (veh/h)			908		110	467

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	654	32	127	625	121
Volume Left	0	0	127	0	14
Volume Right	0	32	0	0	107
cSH	1700	1700	908	1700	528
Volume to Capacity	0.38	0.02	0.14	0.37	0.23
Queue Length 95th (ft)	0	0	12	0	22
Control Delay (s)	0.0	0.0	9.6	0.0	18.2
Lane LOS			A		C
Approach Delay (s)	0.0		1.6		18.2
Approach LOS					C

Intersection Summary			
Average Delay	2.2		
Intersection Capacity Utilization	51.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	24	43	50	1477	2491	59
Future Volume (Veh/h)	24	43	50	1477	2491	59
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	26	46	53	1571	2650	63
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	3542	1325	2713			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3542	1325	2713			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	0	69	64			
cM capacity (veh/h)	3	146	147			

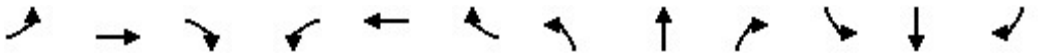
Direction, Lane #	EB 1	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	72	53	786	786	1325	1325	63
Volume Left	26	53	0	0	0	0	0
Volume Right	46	0	0	0	0	0	63
cSH	8	147	1700	1700	1700	1700	1700
Volume to Capacity	9.60	0.36	0.46	0.46	0.78	0.78	0.04
Queue Length 95th (ft)	Err	37	0	0	0	0	0
Control Delay (s)	Err	42.5	0.0	0.0	0.0	0.0	0.0
Lane LOS	F	E					
Approach Delay (s)	Err	1.4			0.0		
Approach LOS	F						

Intersection Summary			
Average Delay	163.8		
Intersection Capacity Utilization	79.5%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	180	16	12	890	1744	409
Future Volume (vph)	180	16	12	890	1744	409
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.5	5.0	4.0	6.0	6.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	1770	3539	3539	1583
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	182	16	12	899	1762	413
RTOR Reduction (vph)	0	11	0	0	0	60
Lane Group Flow (vph)	182	5	12	899	1762	353
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4!		1	Free!	2 9	
Permitted Phases		4				2 9
Actuated Green, G (s)	19.8	19.8	2.8	139.4	100.3	100.3
Effective Green, g (s)	19.8	19.8	2.8	139.4	100.3	100.3
Actuated g/C Ratio	0.14	0.14	0.02	1.00	0.72	0.72
Clearance Time (s)	5.5	5.5	5.0			
Vehicle Extension (s)	3.0	3.0	3.0			
Lane Grp Cap (vph)	251	224	35	3539	2546	1138
v/s Ratio Prot	c0.10		0.01	0.25	c0.50	
v/s Ratio Perm		0.00				0.22
v/c Ratio	0.73	0.02	0.34	0.25	0.69	0.31
Uniform Delay, d1	57.2	51.5	67.4	0.0	10.9	7.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	9.9	0.0	5.8	0.2	1.1	0.3
Delay (s)	67.1	51.5	73.2	0.2	12.0	7.4
Level of Service	E	D	E	A	B	A
Approach Delay (s)	65.9			1.1	11.1	
Approach LOS	E			A	B	

Intersection Summary			
HCM 2000 Control Delay	11.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	139.4	Sum of lost time (s)	22.5
Intersection Capacity Utilization	70.3%	ICU Level of Service	C
Analysis Period (min)	15		

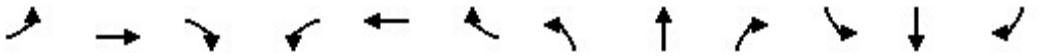
! Phase conflict between lane groups.
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	31	55	114	112	60	65	83	829	81	75	1374	41
Future Volume (vph)	31	55	114	112	60	65	83	829	81	75	1374	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		7.0	7.0		7.0	4.0	5.0	8.0	8.0	5.0	8.0	8.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.98	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1830	1583		1804	1583	1770	3539	1583	1770	3539	1583
Flt Permitted		0.98	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1830	1583		1804	1583	1770	3539	1583	1770	3539	1583
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	33	59	123	120	65	70	89	891	87	81	1477	44
RTOR Reduction (vph)	0	0	112	0	0	0	0	0	41	0	0	21
Lane Group Flow (vph)	0	92	11	0	185	70	89	891	46	81	1477	23
Turn Type	Split	NA	Perm	Split	NA	Free	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2 9		1	6 9	
Permitted Phases			4			Free			2 9			6 9
Actuated Green, G (s)		15.0	15.0		22.6	168.3	14.1	88.5	88.5	15.2	89.6	89.6
Effective Green, g (s)		15.0	15.0		22.6	168.3	14.1	88.5	88.5	15.2	89.6	89.6
Actuated g/C Ratio		0.09	0.09		0.13	1.00	0.08	0.53	0.53	0.09	0.53	0.53
Clearance Time (s)		7.0	7.0		7.0		5.0			5.0		
Vehicle Extension (s)		4.0	4.0		4.0		3.0			5.0		
Lane Grp Cap (vph)		163	141		242	1583	148	1860	832	159	1884	842
v/s Ratio Prot		c0.05			c0.10		c0.05	0.25		0.05	c0.42	
v/s Ratio Perm			0.01			c0.04			0.03			0.01
v/c Ratio		0.56	0.08		0.76	0.04	0.60	0.48	0.05	0.51	0.78	0.03
Uniform Delay, d1		73.5	70.3		70.3	0.0	74.4	25.3	19.5	73.0	31.6	18.7
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		5.3	0.3		14.1	0.1	6.7	0.4	0.1	5.3	2.8	0.0
Delay (s)		78.9	70.6		84.4	0.1	81.1	25.7	19.5	78.3	34.3	18.7
Level of Service		E	E		F	A	F	C	B	E	C	B
Approach Delay (s)		74.2			61.3			29.8			36.1	
Approach LOS		E			E			C			D	

Intersection Summary			
HCM 2000 Control Delay	38.6	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	168.3	Sum of lost time (s)	35.0
Intersection Capacity Utilization	77.3%	ICU Level of Service	D
Analysis Period (min)	15		

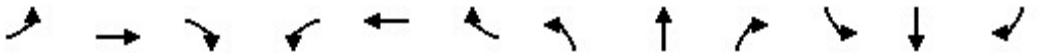
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	1	0	86	0	148	1	973	133	214	1010	2
Future Volume (vph)	0	1	0	86	0	148	1	973	133	214	1010	2
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		7.0		7.0		7.0	5.0	8.0	8.0	5.0	8.0	8.0
Lane Util. Factor		1.00		1.00		1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		1.00		1.00		0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		1.00		0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1863		1770		1583	1770	3539	1583	1770	3539	1583
Flt Permitted		1.00		0.76		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1863		1410		1583	1770	3539	1583	1770	3539	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	0	1	0	95	0	163	1	1069	146	235	1110	2
RTOR Reduction (vph)	0	0	0	0	0	139	0	0	83	0	0	1
Lane Group Flow (vph)	0	1	0	95	0	24	1	1069	63	235	1110	1
Turn Type	Perm	NA	Perm	Perm		Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases		4			8		1	6		5	2	
Permitted Phases	4		4	8		8			6			2
Actuated Green, G (s)		10.1		10.1		10.1	1.5	29.1	29.1	8.0	35.6	35.6
Effective Green, g (s)		10.1		10.1		10.1	1.5	29.1	29.1	8.0	35.6	35.6
Actuated g/C Ratio		0.15		0.15		0.15	0.02	0.43	0.43	0.12	0.53	0.53
Clearance Time (s)		7.0		7.0		7.0	5.0	8.0	8.0	5.0	8.0	8.0
Vehicle Extension (s)		3.0		3.0		3.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)		280		211		237	39	1532	685	210	1874	838
v/s Ratio Prot		0.00					0.00	c0.30		c0.13	0.31	
v/s Ratio Perm				c0.07		0.02			0.04			0.00
v/c Ratio		0.00		0.45		0.10	0.03	0.70	0.09	1.12	0.59	0.00
Uniform Delay, d1		24.3		26.0		24.6	32.1	15.5	11.3	29.6	10.8	7.4
Progression Factor		1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.0		1.5		0.2	0.3	1.8	0.1	97.7	0.8	0.0
Delay (s)		24.3		27.5		24.8	32.4	17.3	11.4	127.3	11.6	7.4
Level of Service		C		C		C	C	B	B	F	B	A
Approach Delay (s)		24.3			25.8			16.6			31.8	
Approach LOS		C			C			B			C	

Intersection Summary			
HCM 2000 Control Delay	24.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	67.2	Sum of lost time (s)	20.0
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	18	0	0	76	14	1441	79	122	1129	8
Future Volume (Veh/h)	0	0	18	0	0	76	14	1441	79	122	1129	8
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	0	0	19	0	0	78	14	1486	81	126	1164	8
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								Raised			Raised	
Median storage veh)								1			1	
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2187	3011	582	2367	2938	743	1172			1567		
vC1, stage 1 conf vol	1416	1416		1514	1514							
vC2, stage 2 conf vol	771	1595		853	1424							
vCu, unblocked vol	2187	3011	582	2367	2938	743	1172			1567		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)	6.5	5.5		6.5	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	96	100	100	78	98			70		
cM capacity (veh/h)	61	28	456	75	71	358	592			417		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	NB 3	NB 4	SB 1	SB 2	SB 3	SB 4
Volume Total	19	78	14	743	743	81	126	582	582	8
Volume Left	0	0	14	0	0	0	126	0	0	0
Volume Right	19	78	0	0	0	81	0	0	0	8
cSH	456	358	592	1700	1700	1700	417	1700	1700	1700
Volume to Capacity	0.04	0.22	0.02	0.44	0.44	0.05	0.30	0.34	0.34	0.00
Queue Length 95th (ft)	3	20	2	0	0	0	31	0	0	0
Control Delay (s)	13.2	17.9	11.2	0.0	0.0	0.0	17.3	0.0	0.0	0.0
Lane LOS	B	C	B				C			
Approach Delay (s)	13.2	17.9	0.1				1.7			
Approach LOS	B	C								

Intersection Summary					
Average Delay	1.3				
Intersection Capacity Utilization	53.3%	ICU Level of Service		A	
Analysis Period (min)	15